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AMERICAN MUSEUM OF NATURAL HISTORY

The Bird Rock Group

BY

Frank M. Chapman

Associate Curator of Mammalogy and Ornithology

SUPPLEMENT TO AMERICAN MUSEUM JOURNAL
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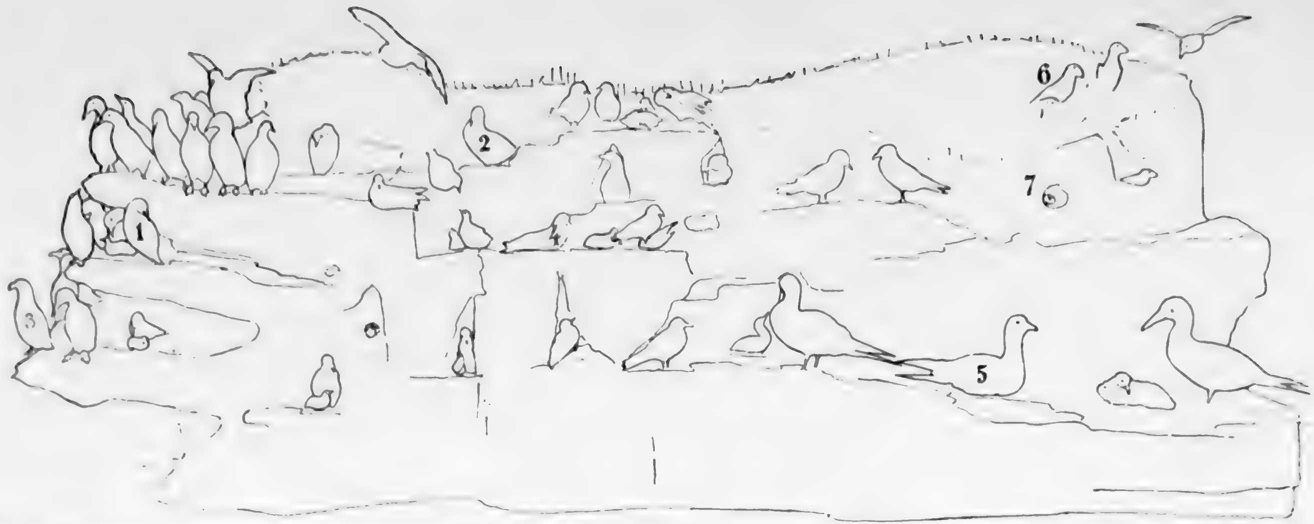
BIRD ROCK FROM THE SOUTHWEST.
Distant about one half a mile.

(From "Bird Studies with a Camera," by permission of D. Appleton & Co.)

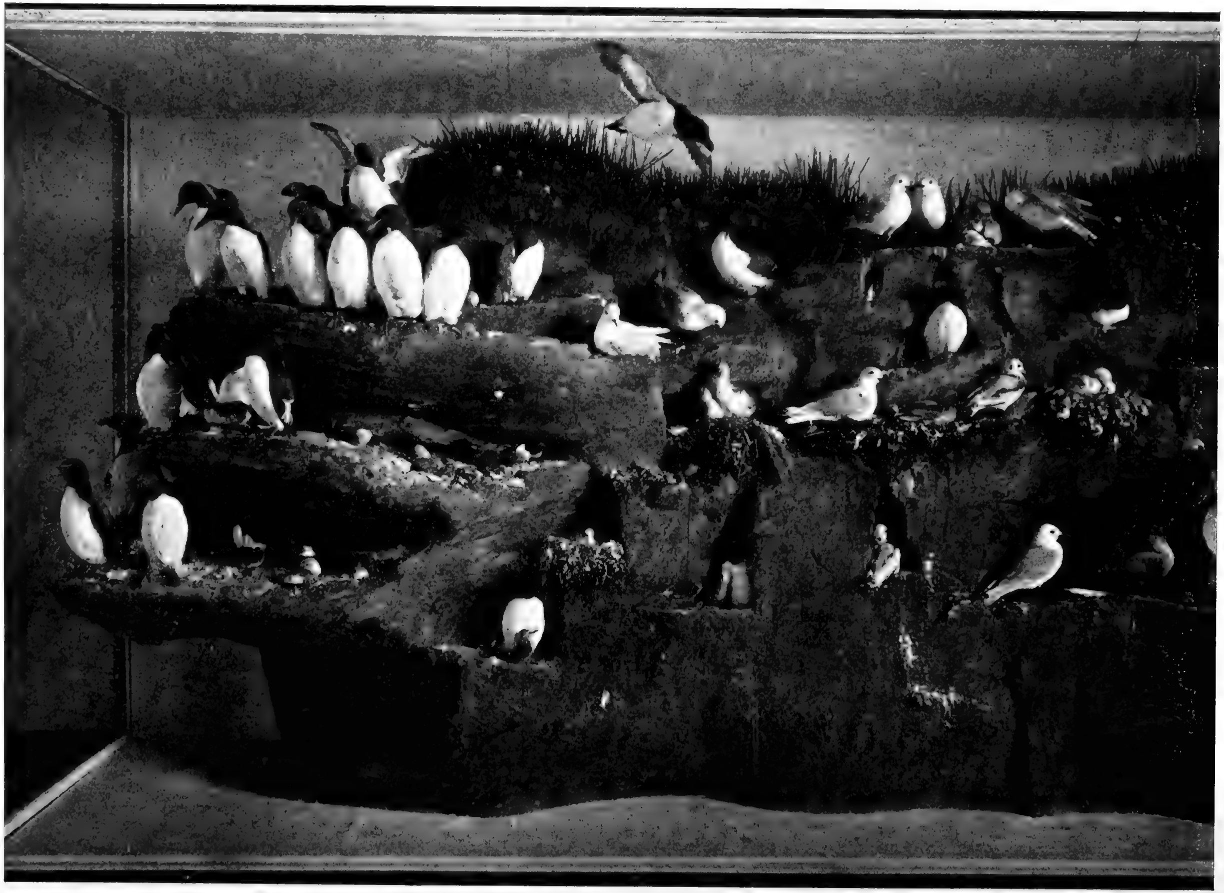
THE BIRD ROCK GROUP.

The group is 17 feet 6 inches long, 6 feet 10 inches high, and contains 73 birds



KEY TO THE BIRD ROCK GROUP.

1, Common Murre. 2, Brünnich's Murre. 3, Razor-billed Auk. 4, Kittiwake Gull. 5, Gannet. 6, Puffin. 7, Leach's Petrel.



LEFT HALF OF THE GROUP.

A DESCRIPTION OF THE BIRD ROCK GROUP ON EXHIBITION IN THE AMERICAN MUSEUM OF NATURAL HISTORY, REPRESENTING A PORTION OF A "BIRD ISLAND" OF THE NORTH ATLANTIC AND THE NESTING-HABITS OF ITS OCCUPANTS.

By Frank M. Chapman,

Associate Curator of the Department of Mammalogy and Ornithology.

Islands as Bird Protectors.

To the preserving influence of island-life we owe the continued existence of many birds which have long ceased to live, or, at least, to nest, on the mainland. This is true of the great oceanic islands as well as of the sand-bars, reefs, and rocks on which sea-birds rear their young, and even of the tiny islet of reeds or vegetable mould which forms the nest of the Grebes (see Group of Pied-billed Grebes in the Main Bird-Hall). In every instance, however, whether the island be a thousand square miles or one square foot in extent, it owes the preservation of its bird-life to the same cause, and this cause is the entire or comparative absence of bird enemies.

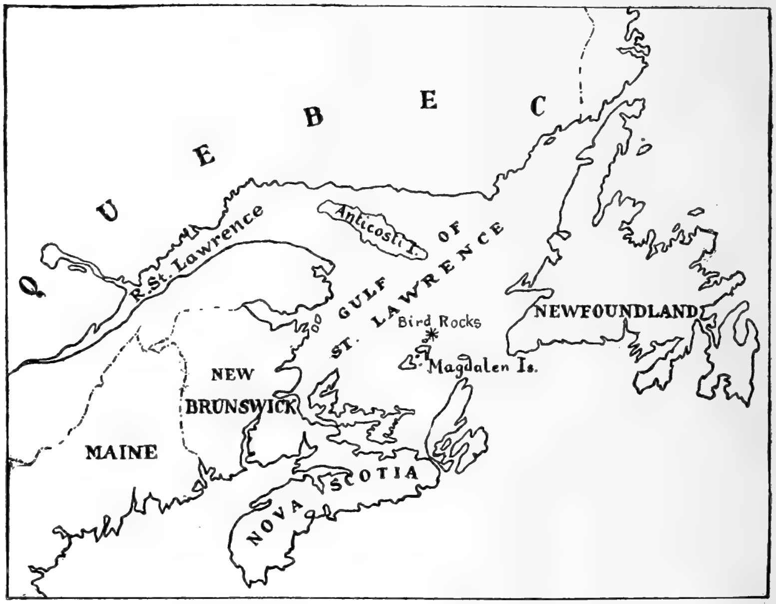
Oceanic islands, or those which have had no connection with the mainland, are, as a rule, without terrestrial mammals, and consequently destructive animals such as wolves, foxes, cats, both wild and domesticated, minks, weasels, etc., are wanting, even when the conditions are favorable to their existence, while the barren rocky islets, reefs, and sand-bars are uninhabited, not only by these predaceous species, but also by the birds' worst enemy—man.

Thousands of instances could be cited to illustrate the importance of the part played by islands in protecting birds, but we need go no farther than our Atlantic coast to be convinced that were it not for islands we should long ago have lost a number of birds which now never nest on the adjoining mainland. For example, practically all our remaining Terns or "Sea Swallows" now breed only on islands, the remaining large colonies of these birds off the New York and Massachusetts coasts being found on

Gardiner's, Fisher's, Muskeget, and Penikese Islands. Martha's Vineyard, between the two last named, contains the sole survivors of the Heath Hen or Eastern Prairie Chicken (see gallery, case J). Certain islets along the coast of Maine form suitable homes for Herring Gulls (see gallery, case B), and going farther north, into the Gulf of St. Lawrence, we find several rocky islets, which, either because of their isolation or precipitousness, are ideal resorts for sea-fowl. Chief among these is

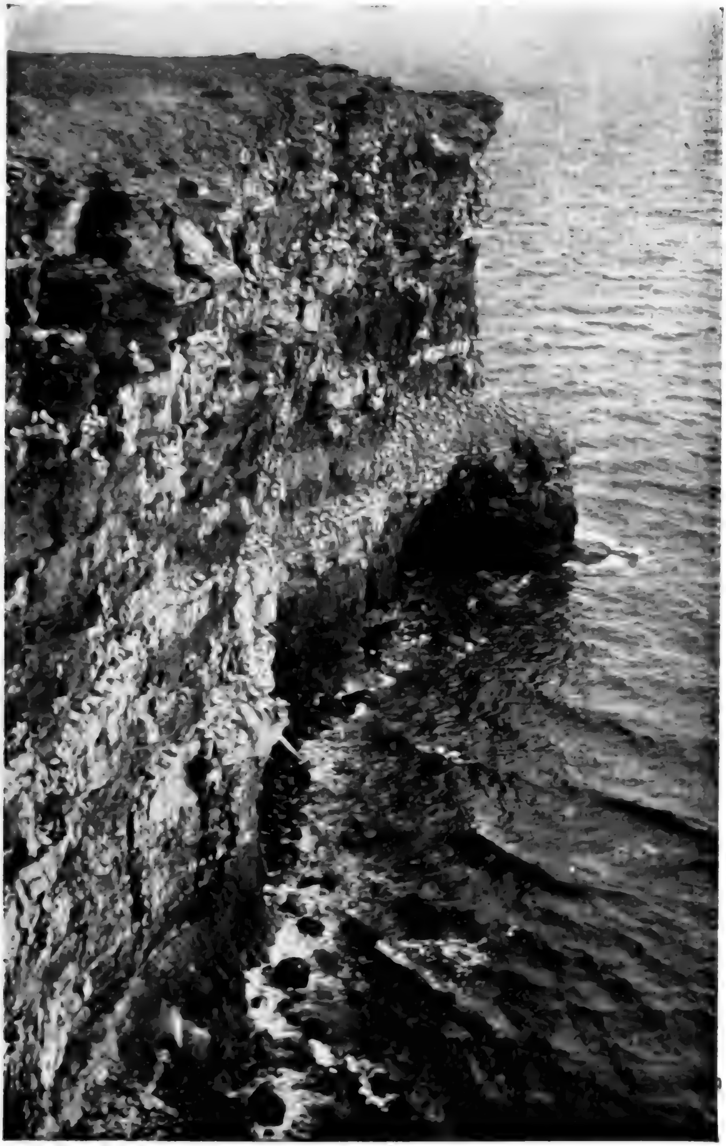
Bird Rock.

Bird Rock, and its neighbor Little Bird Rock, belong to the Magdalen Group, and are situated fifty miles northwest of Cape



MAP SHOWING LOCATION OF THE BIRD ROCKS.

Breton, the nearest mainland, and twelve miles east of Bryon Island, the nearest member of the same group. It is 351 yards long, from 50 to 140 yards wide, and rises abruptly from the sea to a height of from 80 to 140 feet. Its vertical rocky walls are weathered into innumerable ridges, shelves, and crevices — fit sites for the nests of the sea birds which for centuries have made



NORTH SIDE OF THE ROCK, WEST OF THE CRANE.
(From "Bird Studies with a Camera," by permission of D. Appleton & Co.)

the Rock their home. The birds, furthermore, have found an abundance of food in the surrounding waters.

Bird Rock is the home during the summer of seven species of birds. Named in the order of their abundance they are: Common and Brünnich's Murres, Razor-billed Auks, Gannets, Kittiwake Gulls, Puffins, and Leach's Petrel. Gannets are known to nest in only one other place in this country, Bonaventure Island, about 150 miles northwest of Bird Rock, and the remaining six species rarely or never nest on the mainland; facts which illustrate how well the Rock has filled its office of bird protector. We shall see, however, that owing to man's agency the inhabitants of Bird Rock have greatly decreased in numbers since its discovery.

History of Bird Rock.

The history of the Bird Rocks begins with their discovery by Jacques Cartier, the venturesome French navigator, in June, 1534. Cartier wrote: "These islands were as full of birds as any meadow is of grass, which there do make their nests, and in the greatest of them there was a great and infinite number of that that we called Margaulx that are white and bigger than any geese, which were severed in one part. In the other were only Godetz and Great Apponatz, like to those of that island that we above have mentioned. We went down to the lowest part of the least islands, where we killed above a thousand of those Godetz and Apponatz. We put into our boats as many as we pleased, for in less than an hour we might have filled thirty such boats of them. We named them the islands of the Margaulx."

The birds Cartier called "Margaulx" were undoubtedly Gannets; his "Godetz" were probably Murres and Razor-bills; while there is every reason to believe that his "Great Apponatz," which he had previously found and unmistakably described, were the now extinct Great Auk. It is also of interest to know that at this time, during the proper season, the Rocks were the home of Walrus.

Audubon, whose energy in exploration no ornithologist has surpassed, was the first naturalist beholding Bird Rock to leave us a description of its wonders. On June 14, 1833, during his cruise to Labrador, in the Schooner *Ripley*, he wrote in his journal the following graphic account of the day's experiences: "About

ten a speck rose on the horizon, which I was told was the Rock. We sailed well, the breeze increased fast, and we neared the object apace. At eleven I could distinguish its top plainly from the deck, and thought it covered with snow to the depth of

GANNETS ON NESTS.
Photographed from nature by F. M. Chapman.
(From "Bird Studies with a Camera," by permission of D. Appleton & Co.)

several feet; this appearance existed on every portion of the flat projecting shelves. Godwin [the pilot] said, with the coolness of a man who had visited this Rock for ten successive seasons, that what we saw was not snow but Gannets. I rubbed my eyes,

took my spy-glass, and in an instant the strangest picture stood before me. They were birds we saw—a mass of birds of such size as I never before cast my eyes on. The whole of my party stood astounded and amazed, and we came to the conclusion that such a sight was of itself sufficient to invite any one to come across the gulf to view it at this season. The nearer we approached, the greater our surprise at the enormous number of these birds, all calmly seated on their eggs or newly hatched broods, their heads all turned to windward and toward us. The air above for one hundred yards, and for some distance around the whole Rock was filled with Gannets on the wing, which, from our position, made it appear as if a heavy fall of snow was directly above us."[1]

After this description one can readily imagine Audubon's disappointment when the freshening wind prevented his landing on the Rock, and we therefore must turn to the account of Dr. Henry Bryant as that of the first naturalist to set foot on Bird Rock. This was on June 23, 1860, when, after a climb which he characterized as both "difficult and dangerous," Dr. Bryant reached the top of the Rock. In addition to the birds found living on the sides of the Rock, he states that its entire northerly half was tenanted by Gannets, and after measuring the area they occupied, he estimated that this one colony alone contained no less than 100,000 birds, while the number living on the sides of the Rock and on Little Bird he placed at 50,000.[2]

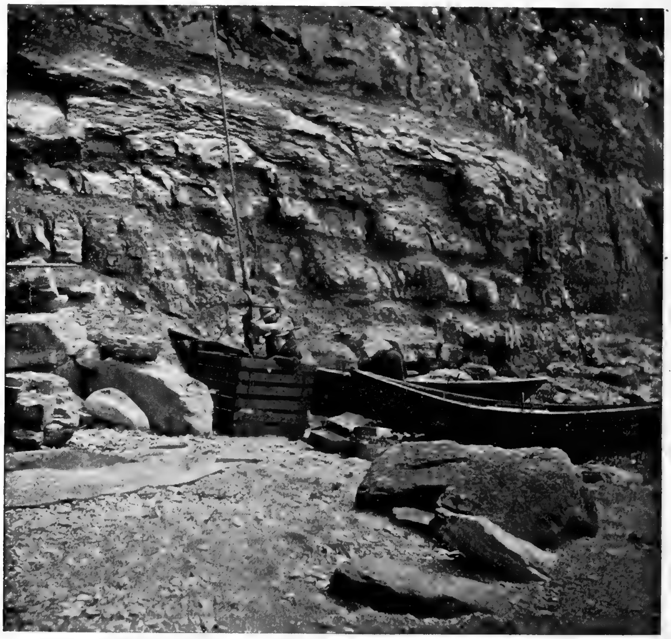
Bryant was followed by Maynard, Brewster, Cory, Lucas, and others, but in the meantime a change had occurred which made the Rock more accessible and at the same time greatly reduced its feathered population. In 1869 a lighthouse was erected on its summit and within three years the colony of Gannets nesting there decreased from 100,000 to 5000 birds; while nine years later only 50 birds remained.

This practical extermination of the summit-nesting birds was due in part to the light-keepers, who evidently did not care for the close companionship of 50,000 pairs of by no means sweet-voiced birds, and, later, to the use of a cannon, which, during the fogs so prevalent in this region, was discharged at short

[1] Audubon and his Journals, I., p. 360.
[2] Bryant, Proc. Bost. Soc. Nat. Hist., 1861.

GANNET (FLYING OVER), MURRES PUFFINS, AND RAZOR-BILLED AUKS.
Photographed from nature by F. M. Chapman.
(From "Bird Studies with a Camera," by permission of D. Appleton & Co.)

intervals to warn vessels of their proximity to the Rock. To the use of this cannon is also in part attributable the diminution in the ranks of the other birds inhabiting the Rock, and, writing of his visit in 1881, Mr. William Brewster remarks: "At each discharge the frightened Murres fly from the Rock in clouds, nearly every sitting bird taking its egg into the air between its thighs and dropping it after flying a few yards. This was repeatedly



THE LANDING AT THE BASE OF THE ROCK, SHOWING CRATE.
(From "Bird Studies with a Camera," by permission of D. Appleton & Co.)

observed during our visit, and more than once a perfect shower of eggs fell into the water about our boat."[1]

Bird Rock To-Day.

In spite of the great decrease which has occurred in Bird Rock's population, it still remains one of the ornithological wonders of our Atlantic coast. Unfortunately, however, the

[1] For a further history of Bird Rock see Brewster, Proc. Bost. Soc. Nat. Hist., 1883. Lucas, "The Auk"—New York—V., 1888, pp. 129, 278; also, in connection with the identity of Apponatz, Hardy, *Ibid.*, 380, Chapman, "Bird Studies with a Camera."

wholesale collecting of eggs and wanton killing of birds by fishermen, combined with the results of firing the gun-cotton bombs, which have superseded the cannon, are causing a continued diminution in the number of birds inhabiting the Rock,

THE LANDING ON TOP OF THE ROCK, SHOWING CRANE.
(From "Bird Studies with a Camera," by permission of D. Appleton & Co.)

and unless the Canadian Government soon takes proper steps to afford them protection, it is quite probable that in time only a fraction of their present numbers will remain. To make, therefore, a permanent record of this characteristic phase of island life

the writer visited the Rock in July, 1898, and procured for the American Museum of Natural History the material and photographs which made possible the preparation of this group.

It is quite as difficult to land on Bird Rock to-day as it was in Audubon's time, but good fortune brought us to the spot during calm weather, and the boat in which the light-keeper met our schooner was readily beached on the hand's-breadth of shore constituting the only port of entry. Once landed, however, the top is now easily reached in a small crate which is hoisted by means of a crane and windlass, operated by the keeper of the lighthouse. The experience of passing so near nesting Murres and Kittiwakes that they may almost be touched is not the least interesting part of a journey through space which it is believed most visitors to the Rock will find possessed of more or less novelty. Alighting on the grassy summit of the Rock, one sees that it contains, in addition to the light- and bomb-houses, a small collection of buildings for the storage of supplies which are brought only twice each year, and for the accommodation of the keeper, his family, and three assistants. With the exception of a few Puffins and Petrels, which live in burrows, no birds now nest on top of the Rock, but they crowd the jutting ledges or eroded shelves of the precipitous faces of the island. In places one can easily clamber down to these ledges and there he will be surrounded by curious groups of sea-fowl, some fearlessly standing, while others whirl by in an endless procession.

In view of the years of persecution to which these birds have been subjected, they are still remarkably tame, and, to a bird-lover, it is an especially grateful experience to be at once received into their ranks. No one, indeed, who has not had the experience can imagine the peculiar sensations which possess the naturalist when, for the first time, he visits a bird island where essentially primeval conditions prevail, and where the birds are so abundant and so unsuspicious that one seems to have reached the heart of the bird world and found existing there the ideal relation between man and the lower animals.

THE BIRDS OF THE ROCK.

Murres (*Uria lomvia et Uria troile*). The Murres, together with the Razor-billed Auk and the Puffin, are members of the

(From "Bird Studies with a Camera,"
(by permission of D. Appleton & Co.)

KITTIWAKES AND YOUNG ON NESTS.

Photographed from nature
by F. M. Chapman.

family Alcidæ, a group of sea-birds found only in the North Atlantic and North Pacific. (Several allied species may be found in the general collection of North American Birds, see gallery, Case A.) Everywhere they are island-nesting birds, indeed some of the largest bird islands in northern seas are inhabited almost entirely by Murres:—the Farne Islands off the eastern coast of northern England, the Farallones at the entrance of San Francisco

COMMON MURRE AND EGG.
From the Group.

Bay, and St. Paul Island in Bering Sea, are tenanted by countless individuals of these birds. Murres feed on fish, which they secure by diving, using both wings and feet in propelling themselves while under water. Their note is a hoarse call sounding somewhat like the syllable *murre*, whence their common name. They make no nest, but lay their one peculiarly shaped and colored egg on an exposed ledge of rock or in a similarly unprotected place. The shape of the egg is supposed to be an adaptation to the requirements of the nesting sites, from which a more elliptical or spheri-

cal egg would roll and fall. The pear-shaped Murres' eggs, however, when moved by the bird or wind, revolve about their own point, practically without change of position. The wide variation in the colors of Murres' eggs, no two of which are alike, is thought to aid the birds in recognizing their own eggs.

BRÜNNICH'S MURRE.
From the Group.

When hatched the Murres are covered with a sooty black down. In some instances they are taken to the water when still very young; in others they acquire the power of flight before leaving their birth-place.

Murres' eggs are edible, and for this reason they are often gathered in large numbers by fishermen, or, when they can be disposed of, by "eggers" who make a business of visiting the

haunts of the birds during the egg-laying season. It is stated that some twenty years ago 30,000 dozen Murres' eggs were gathered annually on the Farallone Islands and sold in the San Francisco markets. As a result of this wholesale robbing, the birds decreased in numbers so rapidly that the United States Government forbade their further molestation. It is greatly to be hoped that the Canadian Government will soon take steps to afford similar protection to the Murres of Bird Rock.

Two species of Murres inhabit Bird Rock, the Common Murre (*Uria troile*) and Brünnich's Murre (*Uria lomvia*). To the casual observer the differences distinguishing them are not at once apparent, and the presence of two such closely related birds, of similar habits, in the same place, is an interesting illustration of the retention of specific differences under circumstances unusually favorable for interbreeding.

The Common Murre has a longer, more slender bill and browner head than Brünnich's Murre, which has a relatively short and thick bill with the basal edges of the lower mandible grayish and swollen, and the head dark. The downy young of the Common Murre are sooty black, sprinkled with white; those of Brünnich's Murre are decidedly browner. The Common Murre breeds in the North Atlantic from Bird Rock and the British Islands northward. In winter it ranges southward to the coasts of Massachusetts and northern Africa.

Brünnich's Murre breeds from Bird Rock northward, but is rare in the eastern Atlantic. In winter it is found occasionally as far south as New Jersey, and, sometimes it reaches the interior states as far west as Michigan, by way of the St. Lawrence River and the Great Lakes.

Some Murres have a white ring around the eye extending backward in a white stripe behind it. They are known as "Spectacled Murres," but whether they constitute a distinct species, or are merely an individual variation, is as yet unknown. One individual of this kind is shown in the group.

Razor-billed Auk (*Alca torda*). The Razor-bill is the nearest existing relative of the extinct Great Auk, which it resembles in general appearance, but from which it differs in possessing the power of flight. This species lays its single egg, which is more elliptical than that of the Murres, in natural cavities or other-

wise protected places, and the young are born covered with a brownish down.

The accompanying illustration of the Razor-billed Auk and Great Auk is of interest not alone because the former is and the latter was an inhabitant of Bird Rock, but also because it permits of a comparison of two closely allied birds, one of which has retained, while the other has lost, the power of flight. The Great

GREAT AUK AND RAZOR-BILLED AUK. SHOWING COMPARATIVE SIZE.
From specimens in the American Museum.

Auk, unlike the Razor-bill, nested on low islands to which it could gain access by means of the feet alone. It fed on fish, migration was unnecessary, and as a result of disuse it evidently lost the power of flight, its wings serving only as paddles for propulsion under the water. Hence it fell an easy victim to fishermen, who, landing on the islets to which it resorted, killed it in great numbers for its flesh. The last living Great Auk was seen in 1844, and all that remains of the myriads described by the early voyagers is some 77 skins, a few skeletons, and 70 eggs.

(See especially in this connection the skin, skeleton, and cast of the egg of the Great Auk in the Main Bird-Hall.)

The Razor-bill breeds from the Bird Rocks and British Islands northward and in winter is found as far south as Long Island and the Mediterranean.

KITTIWAKE GULL ON NEST.
From the Group.

Kittiwake Gull (*Rissa tridactyla*). From six to eight hundred Kittiwake Gulls nest on Bird Rock. They place their nests of sea-weed on the less accessible ledges and doubtless for this reason are less preyed upon by man than are the Murres. Kittiwakes are the only birds on the Rock which lay more than one egg; their nests containing two or three. The young are born covered with down, and during their first winter differ from adults in having the tip of the tail and hind neck black. The birds of this species feed on fish and drink salt water in preference to fresh. Their name is derived from their singular call,

which resembles the syllables *kit-ti-wake*, several times repeated. Kittiwakes nest from Bird Rock and the British islands northward, and in winter range southward to Virginia and the Canaries.

During their winter wanderings Kittiwakes are true sea-gulls,

GANNET.
From the Group.

rarely visiting our inner harbors and bays, where the common winter gull is the Herring Gull, the adults of which, though much larger, are not unlike adult Kittiwakes in color; those born the preceding summer being grayish. (See gallery, case B, for this and other species of American gulls.)

Gannet (*Sula bassana*). Gannets nest on certain small islets off the British coast, in the Faroes, and in Iceland, but in America breed only on Bird Rock and Bonaventure, 150 miles to the west. In the winter they range southward, keeping usually well

off-shore, to northern Africa and the Gulf of Mexico. Of the 100,000 Gannets which were estimated by Mr. Bryant to be nesting on the top of Bird Rock in 1860, no mention being made of those occupying the sides, only about 1,500 remain. Gannets are remarkably impressive birds when on the wing, possessing in an unusual degree power and grace of motion. They secure their food of fish by diving, often from a height of forty feet or more, half closing their wings and plunging into the water with terrific force. The young are born naked, but their black skin is soon covered by white down, which, before they leave the nest, is replaced by gray plumage.

Gannets are the only representatives of their family in northern waters, the remaining species of the group being found in the tropics, where they are known by the name of Booby. Whenever found, however, they are island-nesting birds, not one species of Gannet, so far as known, nesting on the mainland. (For other species, see gallery, case C.)

Puffins (*Fratercula arctica*). Not more than two hundred Puffins breed on Bird Rock. They place their nest, with its single white egg, at the end of burrows which they excavate near the summit of the Rock. When captured, the birds make every effort to use their singularly formed bill, and as a weapon of defense they can inflict a dangerous wound with it.

When walking or perching they stand erect on the toes, while the Murres and Razor-bills rest on the whole foot. Puffins are called "Paroquets" by the French Canadians, and both in appearance and actions they resemble those birds. The call of the Puffin, however, is a hoarse grunt, instead of the shrill squawk emitted by the Paroquet.

Closely allied species are found in the North Pacific (see case, this hall), where they are an important article of food among the natives, who also employ their singularly formed bill in the ornamentation of their ceremonial garments. Aprons with Puffin bills attached to them to produce a rattling noise as the wearer danced, may be seen in hall No. 106, on the ground floor of the Museum.

Leach's Petrel (*Oceanodroma leucorrhoa*). Puffins sometimes share their burrows with the Leach's Petrel or "Mother Carey's Chicnke," but these interesting little birds also excavate burrows

of their own. They make their nest of grasses and feathers and lay therein a single white egg.

Although diurnal at sea, where they are a familiar sight as in their search for food they course to and fro over the wakes of vessels, Petrels are nocturnal on land, visiting their nests only

PUFFIN.
From the Group.

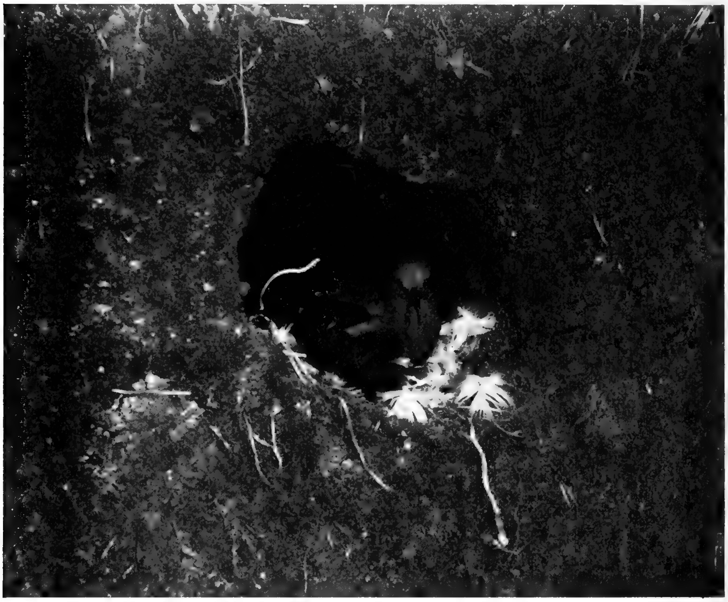
at night to feed their young or change places with their mate, who has passed the day upon the nest. At birth the young are so thickly covered with gray down that they have little resemblance to birds. Their nocturnal habits have led to the general belief that Petrels never visit the land and that they hatch their egg beneath their wing.

Petrels are relatives of the Albatross, which, with other members of the same order (Tubinares, or tube-nosed birds, in

reference to the peculiar shape of the nostrils), may be found in gallery, case C, and main Bird Hall, case B.

The Making of the Group.

In the accompanying group the preceding seven species of birds are shown with their nests, eggs, and young. While the attempt to bring them within the comparatively narrow limits of a museum case has necessitated the combination of typical sec-



LEACH'S PETREL AND YOUNG IN NEST.
From the Group.

tions of the Rock, the birds nevertheless have been arranged with due reference to their association in life, and it is believed that when taken in connection with the photographs from nature displayed on top of the case, the group correctly represents the conditions of bird life prevailing on Bird Rock.

The birds were mounted and their surroundings prepared, under the writer's direction, by Mr. H. C. Denslow of the Museum's Department of Taxidermy.

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Free admission to Museum on Mondays and Tuesdays.
Free admission to Special Courses of Lectures.
Four complimentary Lecture Tickets are sent to each Member.
Four complimentary Admission Tickets are sent to each Member.
The Journal is sent free to Members.
Guide Leaflets are given free to Members.
The use of the Library is enjoyed by Members.
The Study Collections may be consulted by all Members.

The Museum is open to the public WEDNESDAYS, THURSDAYS, FRIDAYS and SATURDAYS and on all LEGAL HOLIDAYS, from 9 A. M. to 5 P. M. On SUNDAYS from 1 to 5 P. M. On TUESDAY and SATURDAY EVENINGS from 7 to 10 o'clock.

On MONDAYS and TUESDAYS, Members, Pupils (accompanied by teachers), Special Students and Artists are admitted free. Others are admitted on the payment of twenty-five cents.

AMERICAN MUSEUM OF NATURAL HISTORY

The Saginaw Valley Collection

FRAGMENTS OF ANCIENT POTTERY FROM SAGINAW VALLEY, MICHIGAN.

BY

Harlan I. Smith

Assistant Curator of Archæology

SUPPLEMENT TO AMERICAN MUSEUM JOURNAL

VOL. I, NO. 12, NOVEMBER-DECEMBER, 1901

W. J. Melchers, Photo.

FOBEAR MOUND No. 1.

THE CULTURE OF THE PEOPLE ONCE INHABITING A LIMITED AREA NEAR SAGINAW, MICHIGAN, AS ILLUSTRATED BY MATERIAL IN THE ANTHROPOLOGICAL DEPARTMENT OF THE AMERICAN MUSEUM OF NATURAL HISTORY.

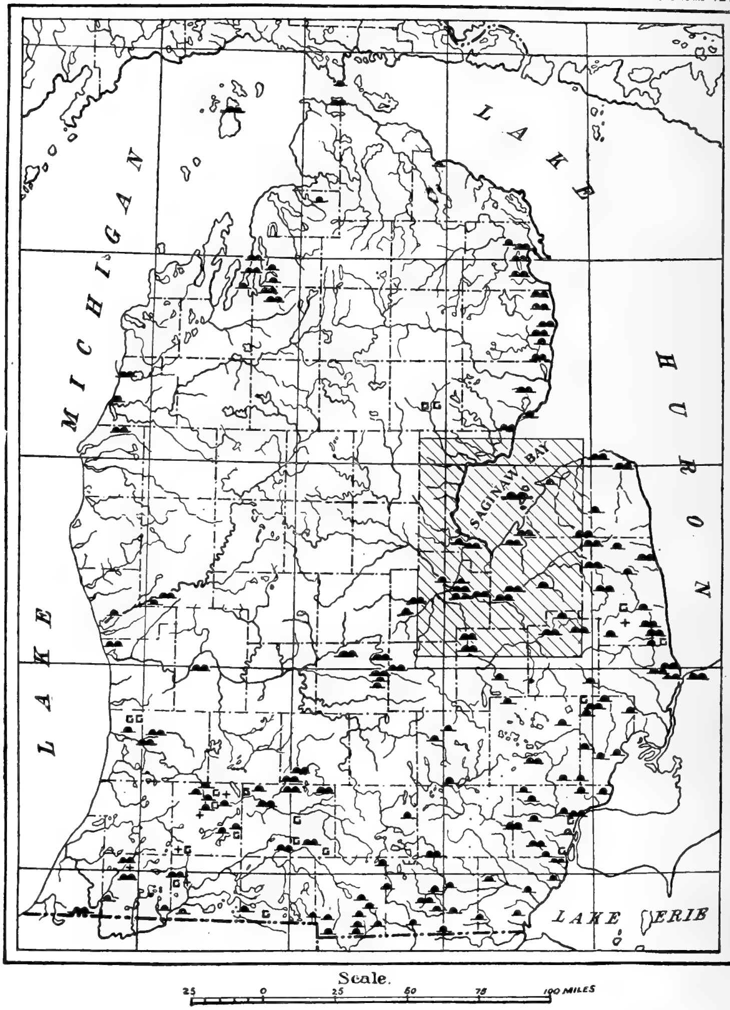
By Harlan I. Smith,

Assistant Curator of Archæology.

The rude archæological objects found in the Saginaw valley, Michigan, and exhibited in the American Museum of Natural History show that the prehistoric people who lived in that area were largely occupied with striving for the necessaries of life. The region, although not at all desolate, was still too far north to support a civilization that would leave traces of a culture so largely given to art and ritual as those to be found in Mexico, the Southern States or even in the Ohio valley. Such a collection of rather rude implements and objects has value, however, in that it gives evidence regarding the lives of the early inhabitants of the country.

The objects from the Saginaw valley were found in such places that we now know where there were a number of rather important villages and a still larger number of small villages or camp sites, besides what were probably scattered habitations and burial-places—all of the early people of this region. It is quite evident from areas where certain stray objects were found, and from the scarcity of other evidences in such areas, that the people also made trips to points remote from the villages, probably for fishing and hunting, the gathering of fruits and roots or the securing of material out of which to make arrow-points and pipes; and that the objects were lost on the way. It would seem that the character of the country, with the scattered distribution of its products, was the cause of the segregation of the people into small villages, and possibly of their establishing small outlying camps for the purpose of being, at certain seasons, near points suitable for such occupations as are above noted.

The importance of the collection exhibited in these cases is chiefly that it indicates the character of the culture of the people, the location of their habitations, burial-places, caches and



ARCHEOLOGIC MAP OF MICHIGAN

A larger map of the cross-lined area will be found on page 8.

mounds, as well as that it shows something of their resources, industries and customs. It is undoubtedly the largest archæological collection from the Saginaw valley, and was made and presented to the Museum by the writer, whose investigations of the region, although supplemented by later work, were chiefly accomplished during the period from 1883 to 1891. Practically all the objects to be found on the surface of the particular sites from which the

W. Orchard, Photo.

Wedge Shaped. CELTS OR CHISELS. Adze Shaped.
About ⅔ Natural Size.

collection was obtained have been secured; but it is probable that further search, especially below the surface and in the neighboring fields, would bring to light other specimens of similar nature.

The Saginaw valley, including the entire area draining into Saginaw Bay, occupies the east-central portion of the southern peninsula of Michigan. It is a well-watered, level country, formerly covered by dense forests of pine, oak, elm, ash, maple, hickory and other trees. The lowlands are occupied by swamps, which in places are largely grown up with wild rice, known to botanists as

Zizania aquatica Linn, a staple produced by nature in such abundance that it was of great importance to the primitive people of the region. The streams which were of the most importance to the prehistoric inhabitants of the valley were the Saginaw river and its main tributaries, including the Shiawassee, Flint, Bad, Cass, Tittabawassee and their branches, while the Pigeon, Sebewaing, Kawkawlin and Rifle were not unimportant. Bordering the lower

W. Orchard, Photo.

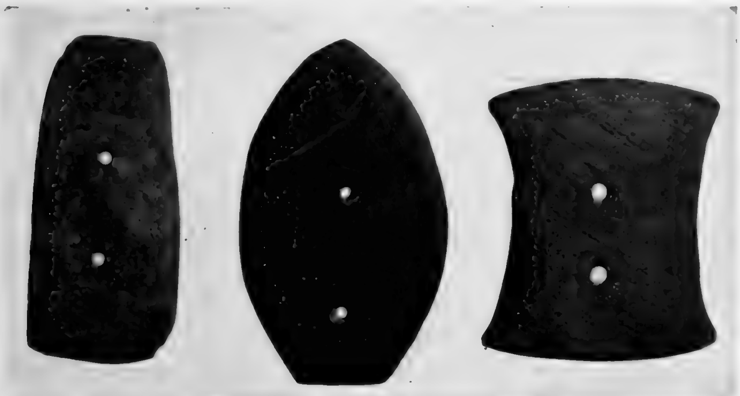
CHERT NODULE IN LIMESTONE.
From Bay Port Quarries.

courses of the rivers there are numerous bayous with low sand ridges scattered over the land between them. At the head waters the streams flow more swiftly and undercut their banks, and large bayous and swamps are less frequent.

Chert or impure flint was extensively quarried and chipped into implements by the prehistoric inhabitants of the valley, and in the chipped implements found on the village sites and hunting-grounds this material largely predominates. A specimen of limestone of Subcarboniferous age bearing a nodule of chert, obtained at the modern quarries at Bay Port, Michigan, is illus-

trated on the preceding page, and may be seen in the case. This outcrops in a nearly circular line cut by the head waters of the Cass, Shiawassee and Tittabawassee and intersecting Saginaw Bay near Point Lookout and Bay Port.

When white men first visited this region, it was inhabited by the Ojibwa Indians. The name of this tribe is variously spelled, as Chippewa, Otchipwe, etc. Their descendants preserve traditions that the Sauk or Sac Indians formerly occupied the valley and were driven out by the Ojibwa and their allies, while the Sac and Fox Indians of Iowa, for their part, have traditions to the same effect. A collection from these Ojibwa Indians is shown



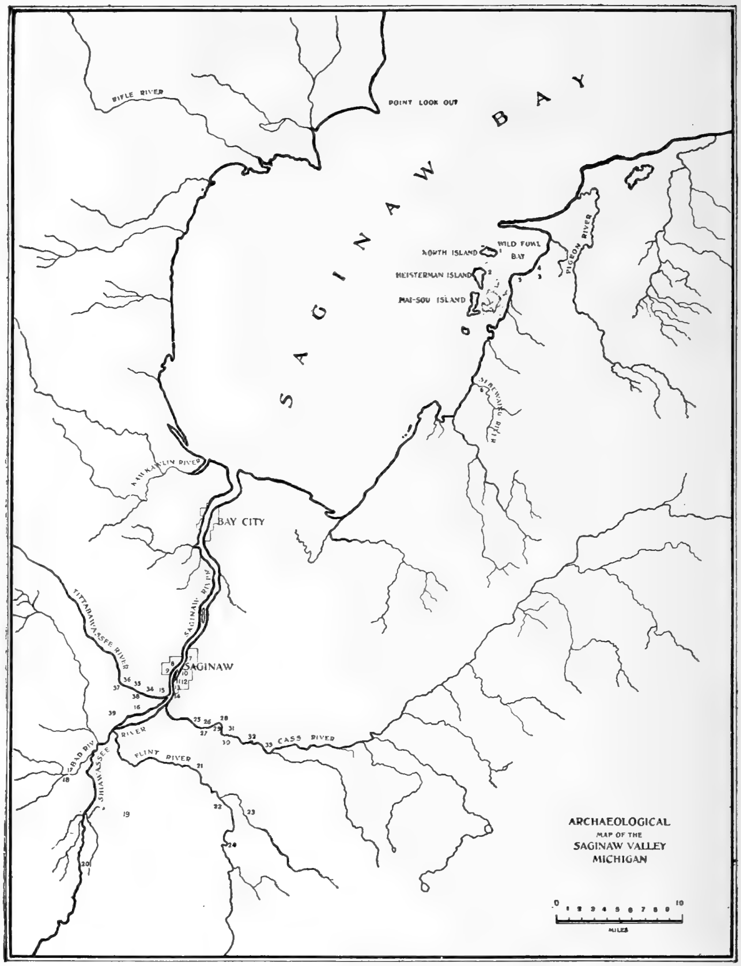
W. Orchard, Photo.

SLATE TABLETS POSSIBLY ORNAMENTS.

About ⅝ Natural Size.

in another part of the Museum (Hall No. 106, on the ground floor). They were found subsisting on a variety of natural products, chief among which were wild rice, maple sugar, squash, corn, wild fruits and game.

The prehistoric villages were located along the streams, because of the importance of water, wild rice, fish and the land animals which frequented the river banks for food or visited them for water. Furthermore, the canoe was an easier means of transportation than the trail, and even trails were more easily formed along the ridges parallel to the rivers or along the banks than elsewhere. The outcrops of chert and pipestone also are



ENLARGED MAP OF THE CROSS-LINED AREA ON THE MAP OF THE STATE ON PAGE 4.

ARCHÆOLOGICAL MAP OF THE SAGINAW VALLEY, MICHIGAN, SHOWING THE PRINCIPAL ANCIENT SITES.

SAGINAW BAY, EASTERN SHORE, HURON COUNTY.

1 North Island Workshops.
2 Heisterman Island Village Site.
3 Bay Port Village Site.
4 Bay Port Cache.
5 Sharpsteen Village Site.
6 Sebewaing Village Site.

SAGINAW RIVER VALLEY, SAGINAW COUNTY.

7 Hoyt Camp Site.
8 Wright Graves.
9 Saginaw Graves.
10 Germain Village Site.
11 Ayres Camp Site.
12 Esterbrook Camp Site.
13 Mobray Camp Site.
14 Ka-pay-shaw-wink Village Site.
15 Green Point Mounds.

SHIAWASSEE RIVER VALLEY.

16 Merrill Cache.
17 St. Charles Graves.
18 St. Charles Mounds.
19 Albee Workshop.
20 Chesaning Mounds.

FLINT RIVER VALLEY.

21 Foster Village Site.
22 Peonagowink Village Site.
23 Stewart Cache.
24 Morse Cache No. 1.

CASS RIVER VALLEY.

25 Wille Cache.
26 Fisher Village Site.
27 Fobear Mounds.
28 Andross Village Site.
29 Lull Earthwork.
30 Cass Village Site.
31 Bow Village Site.
32 Cook Village Site.
33 Simons Prehistoric Cemetery.

TITTABAWASSEE RIVER VALLEY.

34 Little Camp Site.
35 Morgan Camp Site.
36 Andrews Workshop.
37 Frazier Village Site.
38 Tittabawassee Village Site.
39 German Camp Site.

W. Orchard, Photo.

HAMMER-STONES.
About ½ Natural Size.

exposed by the rivers, while in other places they are covered with soil. From such exposures canoes could easily descend to villages along the rivers, while to carry the material by trail to inland settlements would have been laborious. The evidences from the numerous village sites and the burial-places, mounds and other remains, indicate that the conditions of life in prehistoric times were similar to those which existed when the Indians were first met by white men. Fragments of pottery; pebbles which have been burned and broken, probably while used as supports for the round-bottomed pottery cooking-vessels; ashes and charcoal ; the broken bones and shells of animals; arrow, knife, spear, scraper and drill points of chert; points made of bone for arrows or awls; celts or chisels; hammer-stones; grooved axes; ornamental objects, etc.—all are to be seen in this case. A number of such objects when found on the surface of the ground at a particular place, especially if pottery is present, constitute the evidence which proves the spot to have been a village site. Charcoal and ashes alone are not conclusive proof of a village site, since such remains may have been left by white people of recent times.

Particular Sites.

North Island Workshops.—At the western limit of Wild Fowl Bay is North Island, on the northern side or highest part of which chert implements were found in all stages of manufacture, from the nodular masses occurring in the substratum of the entire island to the finished chipped points for spears, arrows, knives and similar objects. Here also were found chips, flakes and other discarded fragments of the same material,—the waste from the processes of manufacture,—indicating the site of an ancient workshop. Chipped implements of other material than chert have not been obtained at this locality.

Heisterman Island Village Site.—The highest portion of Heisterman Island is the northeastern side and there the sand ridges slope to the marshes known as the Middle Grounds. These marshes are frequented by fish, and wild fowl assemble here in large numbers to feed on the wild rice. The rice alone, which does not border other portions of the island, may have

W. Orchard, Photo.

GROOVED STONE AXES AND GROOVED STONE HAMMER.

About ½ Natural Size.

determined the site of this prehistoric village. The limestone bearing chert suitable for the manufacture of arrow-points underlies the island and outcrops on its western shore within easy access of this site. Hammer-stones, chipped points for arrows, knives, spears, drills, etc., and chipped flint implements resembling small hoes were gathered here, as well as fragments of pottery and a piece of a pottery pipe. Many of the potsherds are neatly ornamented, some by incised designs, others by designs made by pressing twisted cord or twine into the clay while it was soft. Another important locality is the one known as Bay Port Village Site, from which the grooved stone hammer used for our illustration was taken.

Near some of the villages hidden deposits or caches have been found, fourteen in all having been discovered in the Saginaw valley. The specimens from a number of these may be seen in this collection. That the quarries from which the Indians obtained their raw material have yet to be found is possibly because signs of them may have been obliterated by modern quarrymen or by the grinding of the ice or the beating of the surf against the lake-shore outcrops during the many years which must have elapsed between the time when the Indians abandoned the quarries and the time when the first archæologist saw the site. The caches seem to indicate that expeditions were made to these quarries and a large number of the partly finished forms were chipped, and that they were taken to the vicinity of the permanent camp and cached in the earth, where the stone would be kept from becoming weathered.

Bay Port Cache.—One cross-section of a chert nodule and forty-seven "turtle-back" blank forms, constituting a cache, were found two feet below the surface, in the muck jungle, about a hundred feet from the shore of Wild Fowl Bay, and a quarter of a mile east of the wharf at Bay Port. The place is between the bay and the sand ridge on which the Bay Port village site is located. The specimens in the cache were found in one long row, overlapping one another somewhat like shingles on a roof. It is probable that the material of which they were made was obtained near the spot, since the outcrop of Subcarboniferous rock, which occurs for some distance along the beach westward from the wharf, bears concretions the material of which is similar

to that of the cache specimens. There are several outcrops of this rock within a mile, especially along the beach to the west. In this cache there were some blades of peculiar form, having a straight beveled edge on one side. It seems probable that this was caused by flaking the pieces for turtle-backs from a round concretion. The first flake removed would be symmetrical, but each of the succeeding flakes, if the material were used without waste, would have one side beveled where the one before it had been removed from the nodule. Not all of the flakes had been subjected to sufficient chipping to remove the signs of this bevel.

W. Orchard, Photo.

SEGMENT OF NODULE, RUDE BLANK AND CHIPPED POINT.

From the surface of the Esterbrook Village Site.

About $\frac{3}{4}$ Natural Size.

More or less evidence has been found of the existence of a number of village sites, burial-places, mounds and prehistoric battle-grounds from Bay Port southward along the shore of Saginaw Bay, on the western shore of the bay and along the lower course of Saginaw River. There are Ojibwa traditions also which tend to confirm the archæological evidence. From such sites the quantity of material in this collection is not sufficient to warrant a detailed description of it in this place. This, however, is given in a summary of the Archæology of Saginaw Valley, Michigan, published in the *American Anthropologist* beginning with Part II, 1901. The fragments of pottery, arrow-points and

other objects found on the surface of the sand ridges along the eastern side of Saginaw River in the city of Saginaw, indicate a number of village sites which were separated by bayous. From one of the latter series there has been obtained one of the so-called "bird-shaped" stones which is evidently in process of manufacture. The greater portion of the surface shows the pits caused by "pecking," as it is technically called, that is, the bruising of the surface of the stone and the brushing away of the crushed particles until it has assumed the shape desired. At either side of what was to have been the head, the next process in the manufacture had been taken up, as is shown by the rubbed surfaces. It is probable that this rubbing was done with a rather coarse stone, and that the implement would have been finished by polishing.

W. Orchard, Photo.

"FLUTED" OR CORRUGATED STONE CHISEL.
"Fluted" celts are found only in Michigan and Wisconsin and this form is rare. Collected by Mr. Albert Barkels. Natural Size.

Mobray Village Site.—This site, which is on the east side of the river in South Saginaw, had on its surface a sandstone pipe decorated with neatly arranged pits. Rock which outcrops in the bottom of the Cass river was mentioned as

early as 1859 in the State geological reports as being material used by the Indians of the region for their pipes. It is possible that this pipe was made of similar material which was brought down the Cass by canoe, that being the most natural way; an idea which is strengthened by the fact that the early pioneers depended on the canoe, at first, for transportation along the same route.

Ka-pay-shaw-wink Village Site.—This is a large village site on the east bank of the Saginaw river, just below the junction of the Tittabawassee and Shiawassee rivers. The archæological evidence found at this locality coincides with the Ojibwa traditions, which state that in ancient times a great village of the Sac Indians was located here. A cache consisting of fifty-nine blades was found about a foot below the surface at this spot. The implements found in it are leaf-shaped, average about one and one-fourth inches in length and are of chert. One of the blades had been specialized by notching at the base. This cache is known as Golson Cache No. 2. There are two large dome-shaped mounds on the western side of the river, opposite the Ka-pay-shaw-wink village site, and it is related by the Indian traditions that a part of the exterminated Sacs were buried in them. They are known as the Green Point mounds.

W. Orchard, Photo.
PIPE MADE OF SANDSTONE.
Collected by John Rambow on the Mobray Camp Site. Natural Size.

Wille Cache.— A cache consisting of two celts and about 175 chipped blades of triangular shape averaging an inch and a half in length was found in a small marsh hole or periodic pond near the north bank of the Cass river about three miles from Saginaw. Specimens are shown, also, from various sites on the Shiawassee

and Flint river, but, as in the case of many of the other sites in the region, they must be here passed without further mention.

Fobear Mound No. 1.—A group of four mounds was found on the land of Mr. Leonard Fobear on the south side of the Cass river nearly opposite the Wille cache, or about four miles above Saginaw. One of these was thoroughly explored in 1894 and a number of skeletons, besides fragments of pottery, chips of chert and other objects of like nature were found in it. Persons not acquainted with archæological field-work often ask how the explorer knows where to dig, hence a brief outline of the beginning of operations at this mound may be of some interest. On

Harlan I. Smith, Photo.

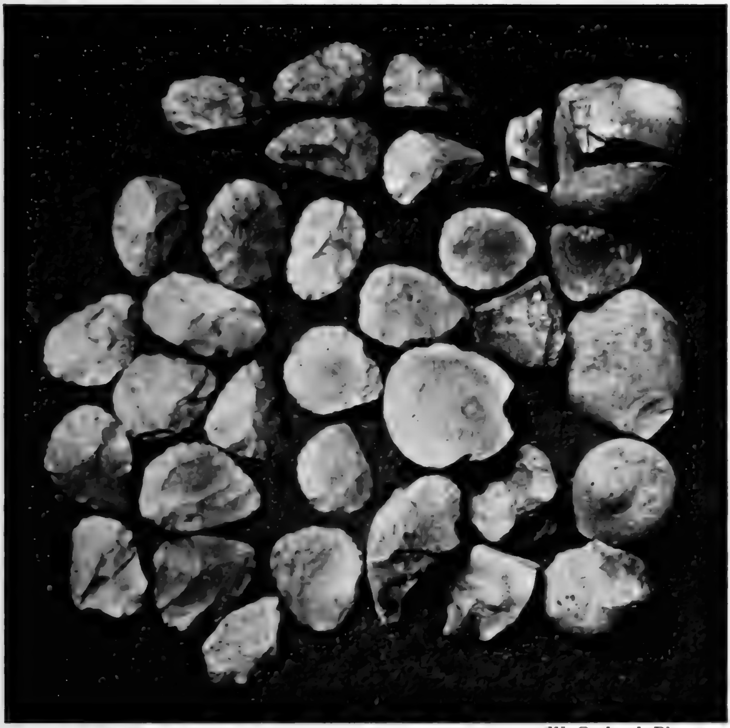
THE EASTERN OF THE GREEN POINT MOUNDS FROM THE SOUTH.

first visiting this locality, the author viewed it from several directions and felt that the mound was of such slight elevation and so much like the natural knolls in the same meadow with it that it might be only a natural rise in the ground; but, on walking over the middle of it, he noticed in the short meadow grass some yellow soil which had been thrown up out of a woodchuck burrow. Such material must have come from below the reach of the plow, since all the surface soil was black. In the yellow earth were several fragments of pottery, but such bits are to be found anywhere in the surface soil of the neighboring fields. A human tooth lying among the potsherds suggested the idea that a human

W. J. Melchers, Photo.

SKELETONS AS FOUND IN FOBEAR MOUND No. 1.

skeleton might be underneath, and that the knoll was in reality a burial mound and not a natural elevation, for human teeth have not yet been brought up from the interior of natural knolls. On excavating the mound, several human skeletons were found near the base of the burrow. Thus the wood-chuck, of interest to the student of mammals, was of assistance to a worker in another department of science.



W. Orchard, Photo.

CASS CACHE No. 2.

Cass Cache No. II.—This cache, consisting of 22 blanks and 12 pieces of nodules of chert, very similar to that of the Subcarboniferous outcrop, was found just below the surface of the earth, near the south bank of the Cass river, at a point about four miles above Saginaw. The 12 pieces of raw material lay in a pile and the 22 blades were spread out near them. Chips and

W. Orchard, Photo.

THE ANDROSS URN.

flakes, also, were abundant near the cache, and it is possible that this was a workshop, the raw material being piled in one place and the worked rock in another, beside it. The blanks found here included both forms described under Bay Port Cache.

Andross Village Site.—This site is at Bridgeport, about six miles from Saginaw, and is one of the many which have been found on the Cass river. It is worthy of note, because it furnished the large pottery urn which is illustrated on page 20, and which is, perhaps, the most interesting specimen in the collection. While a pioneer was plowing on the site, the foot of one of his oxen suddenly sank into a hole. On investigation, the farmer found that the ox had broken through the bottom of an urn which had been turned mouth downward over the head of a human skeleton. This urn is three feet nine inches in circumference and one foot eight inches in height, but before it was broken it must have been at least two feet high. It is reported that a number of similar urns have been found near Detroit, and one was dug up at Point Lookout on the west side of Saginaw Bay; but unfortunately all these specimens have been broken or lost, so that the Andross urn is probably unique.

Andrews Workshop.—On the Tittabawassee river, as on the other streams, we find a number of village sites and burial-places. One is on a sand ridge east of the river, near Paine's Station, about five miles west of Saginaw. Here the wind had blown under some buildings and removed the light sand, leaving a deep hole of considerable area. Over the surface of the sand remaining in this hole were left wagon-loads of chips and flakes of chert, arrow-points in various stages of manufacture, small hammer-stones and a few other objects, all indicating that the place was once a workshop. The hammer-stones are merely pebbles that have been battered in pounding, or pebbles which have been provided with a pit on either side, so that the thumb and middle finger may grasp them more securely. These were used in breaking up the pieces of chert and bringing them somewhat into the form of the chipped points for arrows and similar implements. It is probable that a bone implement was used for the finer flaking necessary to finish the object.

Some copper beads which were found on this site are of particular interest, since they show that the native copper from Lake

Superior, was hammered into the form of beads which are altogether different from those made of the thin rolled copper furnished the Indians by the white people during more recent times. These beads had evidently been at this place for a long time, a circumstance indicated by the corroded condition of the copper. The copper salts due to corrosion are of a preservative nature and have kept from total destruction portions of the cord on

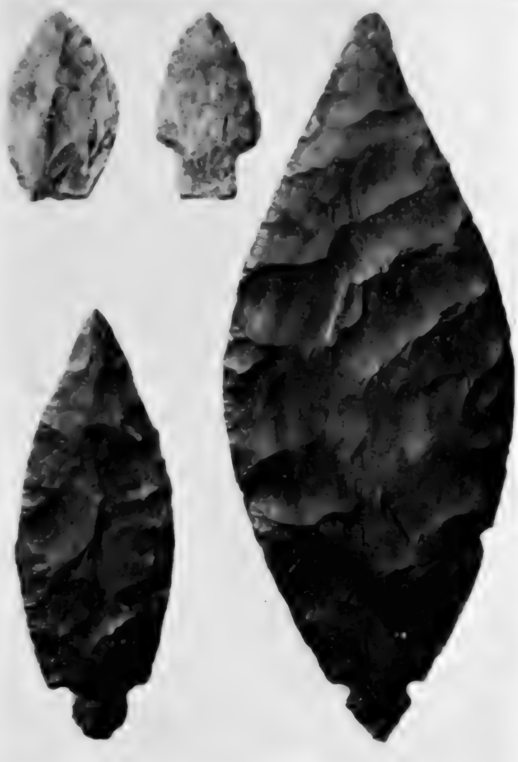
W. Orchard, Photo.

FRAGMENTS OF POTTERY FROM FRAZIER VILLAGE SITE.
Nearly Natural Size.

which the beads had been strung. Had these beads been of shell or stone, or of any other material that did not produce such a salt, the cord would not have been preserved, and we should not have known that it was of vegetable fibre, but might quite properly have supposed that the beads had been strung upon a thong of buckskin.

Frazier Village Site.—This was a very large village site and was located on the south side of the Tittabawassee river near Paine's Station, about five miles above Saginaw. It is mentioned in the Ojibwa traditions as being the place where a large village was captured by the invading force. At this spot some fragments of pottery were secured which have decorations made with cords

like those of the Heisterman Island pottery. A mound of unusually large size is said to have been located on this site and the many human skeletons found here are supposed to have been those of the unfortunate Sacs. This mound has been entirely removed for the commercial purpose of obtaining the sand of which it was constructed. It seems possible that the site was really a burial ground in a natural knoll of sand. A cache consisting of over 300 pieces was found about a foot below the surface on this site. In the cache, which was located within a few hundred feet of the Frazier mound, were found four varieties of blades: First, large, black, leaf-shaped implements, about 8 inches long, made of black, concretionary chert and having a very delicate stem formed at the tip of the base by two notches; Second, similar implements, about 3 inches long, showing concretionary structure very plainly, the centre being black and hard, the tips grading off by successive rings to a comparatively soft yellowish chert; Third, small forms made of yellow chert and



W. Orchard, Photo.
REPRESENTATIVE SPECIMENS FROM FRAZIER CACHE No. 1
About ½ Natural Size.

evidently intended for specialization; Fourth, a few of the latter specialized by notching. Objects made of the same material are only rarely found in the region, hence these were probably brought from a distance. A cache, a few feet from the preceding, consisted of one large, black, leaf-shaped implement, similar to those of the last mentioned and surrounded, it is said, by thirteen rubbed stones.

The foregoing description contains but a general indication of the archæology of the Saginaw valley, as outlined by a single collection. Those who care to pursue the inquiry further are referred to the more detailed descriptions published in the *American Anthropologist*, though even these are not supposed to exhaust the theme presented by this limited area alone. Thorough explorations in the mounds, graves and village sites are necessary to supplement what is now known from the surface evidence and from the few explorations which have been made beneath the surface.

Of the archæology of many other parts of Michigan still less is known, and it is of the greatest importance that thorough work should be done in several centres of culture, not only in the Saginaw valley, but also in other parts of Michigan and in fact throughout the Central States, in order to solve the enigmas that have long puzzled the students of the early Americans. The Mississippi and St. Lawrence valleys are rich in archæological material, but it is almost useless to indulge in speculations derived from scattered bits of evidence from widely separated parts of the country. The time has come when our studies must be based upon exhaustive and detailed investigations made in a scientific manner, at one place. These may then be compared with the results of similar studies carried on at all other parts of the region of which knowledge is desired and substantial progress will be made toward unraveling the history of the early Indian tribes in this country.

American Museum of Natural History.

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AMERICAN MUSEUM OF NATURAL HISTORY

The Hall of Fossil Vertebrates

BY

W. D. Matthew, Ph.D.

Assistant Curator, Department of Vertebrate Palæontology

SUPPLEMENT TO AMERICAN MUSEUM JOURNAL

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Guide Leaflet No. 3

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THE HALL OF FOSSIL VERTEBRATES

THE HALL OF FOSSIL VERTEBRATES.

By W. D. Matthew, Ph.D.,

Assistant Curator, Department of Vertebrate Palæontology.

Introduction.

When we dig beneath the present surface of the ground we sometimes find remains of ancient cities, dwellings, bones of men and animals, buried many centuries ago under accumulations of debris, deposits of river mud or drifted sand. From these we learn many facts concerning the early history of mankind of which there is no written chronicle. From the study of these facts the science of Archæology has arisen, and it deals with the early history of mankind, with the evolution of civilization.

Most of the animals of which the archæologist finds traces are like those now living, although a few have become extinct. But in those more ancient deposits which are now consolidated into clays, sandstones etc., indications of man are not found, and the remains of animals which they contain are unlike any now living —the more unlike as the rock is more ancient. These remains are called *Fossils*. They consist only of the hard parts of animals (bones, shells, spines etc.). The soft parts are never preserved, and only very rarely is some trace of skin or hair, horns or hoofs, to be distinguished. As in the course of ages the mud or sand in which they are buried changes to rock, so little by little the fossils have been changed into a brittle, stony material, while retaining their outward form and usually their peculiar structure. But as mud and clay, in changing into rock, settle down and contract considerably, so also the fossils are flattened out to a corresponding extent—sometimes so much, in the case of a rock which has once been a soft oozy mud, that they suggest rather a picture or a bas-relief than the original form of the animal.

From fossils we can interpret the history of the world of life during the long ages before man appeared. The science which deals with the ancient history and evolution of the animal kingdom is Palæontology (*παλᾶιος*, ancient, *ὄντα*, living beings,

-λογία, science). It tells us of a long period of time before Man appeared, probably millions of years, during which Mammals of great size and unfamiliar form were the dominant animals—of a yet longer era before that, during which huge Reptiles were rulers of earth, sea and air—and of other more ancient periods during which Amphibians, Fish and Invertebrate animals held sway in turn. Vertebrate Palæontology deals only with the higher classes of fossil animals, the Vertebrata, or those that have backbones (fish, amphibians, reptiles, birds and mammals). For fossils of this kind the Bad-Lands of the Western States are the richest field, and from there came nearly all the specimens in this hall, the greater part of which have been found within the last ten years. The hall was opened in 1895.[1] At the time of writing, thirty complete skeletons of extinct animals have been placed on exhibition, besides many times that number of skulls, limbs and other imperfect specimens.

To give the visitor a clear idea of these extinct animals, the skeletons usually have been removed entirely from the rock in which they were found and have been mounted as much as possible like skeletons of modern animals; their probable appearance and habits are described by the labels and illustrated by water-color restorations. The especial interest of the hall lies in the fact that it shows so many of the data upon which are based the theories of Evolution. The arrangement of the specimens is intended to show the history or evolution of different races of animals, chiefly in North America. All the specimens of one race or kind of animal have been placed together, the most ancient first, the most recent last. All the skeletons in this hall are those of extinct animals.[2] The *Mastodon* and *Great Irish Deer* are half-petrified bone dug out of peat bogs. All the others are petrified (*i. e.*, they have been buried so long that they have been converted from bone into stone), and have been chiseled out of the solid rock. The *Megatherium* is a plaster cast, taken from bones from

[1] A brief history of the Department will be found in the number of this JOURNAL for November–December, 1901.

[2] Four small skeletons, those of the Raccoon, Cat, Opossum and young Lamb, have been placed in the cases near their extinct relatives, for comparison.

South America now in the museum of the Royal College of Surgeons, London. Some of the skeletons are partly restored in plaster, indicated by a red cross (restored bones) or red lines (outlines of restored parts of bones). Bones supplied from other specimens are marked with the catalogue number of the specimen or are indicated by a red circle, if uncatalogued.

GEOLOGICAL AGES AND PERIODS.

<table>
<tr><td rowspan="2">Cenozoic</td><td>Quaternary</td><td>Age of Man,
50,000 years</td></tr>
<tr><td>Tertiary</td><td>Age of Mammals,
3,000,000 years</td></tr>
<tr><td rowspan="3">Mesozoic</td><td>Cretaceous</td><td rowspan="3">Age of Reptiles,
7,000,000 years</td></tr>
<tr><td>Jurassic</td></tr>
<tr><td>Triassic</td></tr>
<tr><td rowspan="5">Palæozoic</td><td>Permian</td><td rowspan="2">Age of Amphibians and Coal Plants,
5,000,000 years</td></tr>
<tr><td>Carboniferous</td></tr>
<tr><td>Devonian</td><td>Age of Fishes,
2,000,000 years</td></tr>
<tr><td>Silurian</td><td rowspan="2">Age of Invertebrates,
10,000,000 years</td></tr>
<tr><td>Cambrian</td></tr>
<tr><td rowspan="2">Eozoic</td><td>Algonkian</td><td rowspan="2">(No fossils)</td></tr>
<tr><td>Archæan</td></tr>
</table>

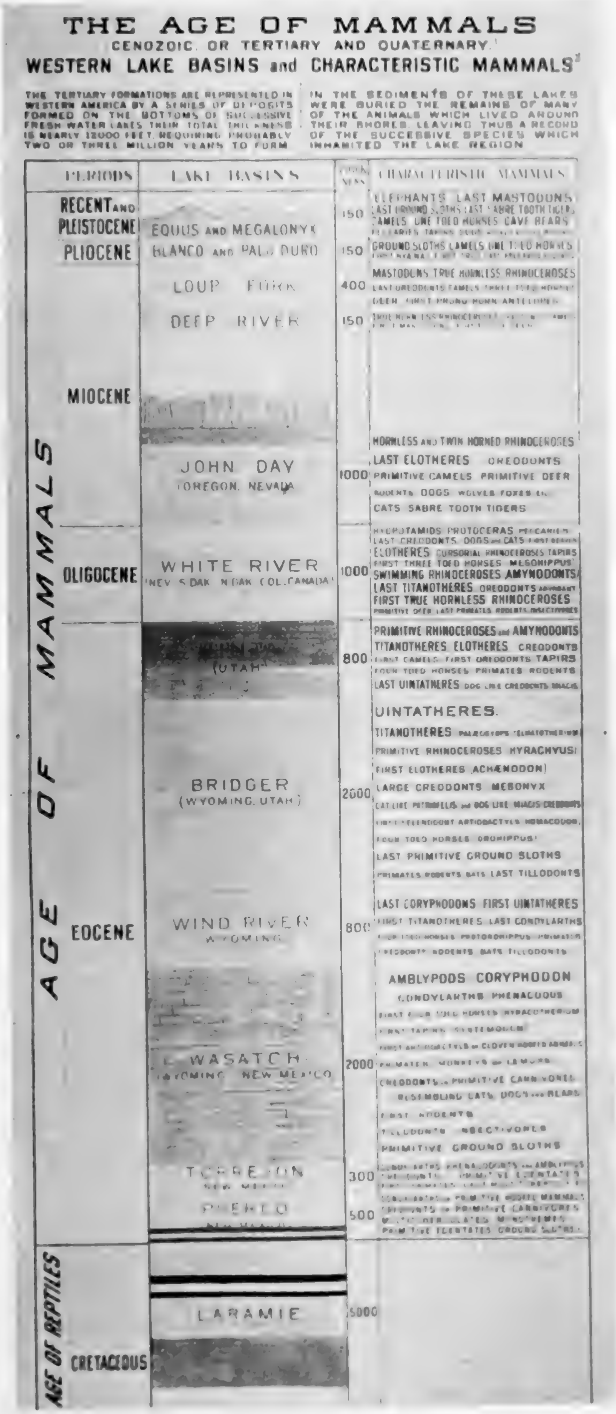
These estimates in years of the geological periods given in the accompanying table, which is arranged in descending order from the most recent to the most ancient time, must be understood to be merely very rough approximations. There is no known method of finding any exact equivalent in years of any geological period, although the relative length of each to each is

THE AGE OF REPTILES
(MESOZOIC)
GEOLOGICAL FORMATIONS and CHARACTERISTIC ANIMALS.

THE AGE OF REPTILES PRECEDED THE AGE OF MAMMALS, AND IS REPRESENTED IN VARIOUS PARTS OF THE WORLD BY MARINE, ESTUARY AND FRESH-WATER DEPOSITS DIVIDED INTO THREE GREAT PERIODS, TRIASSIC, JURASSIC AND CRETACEOUS.

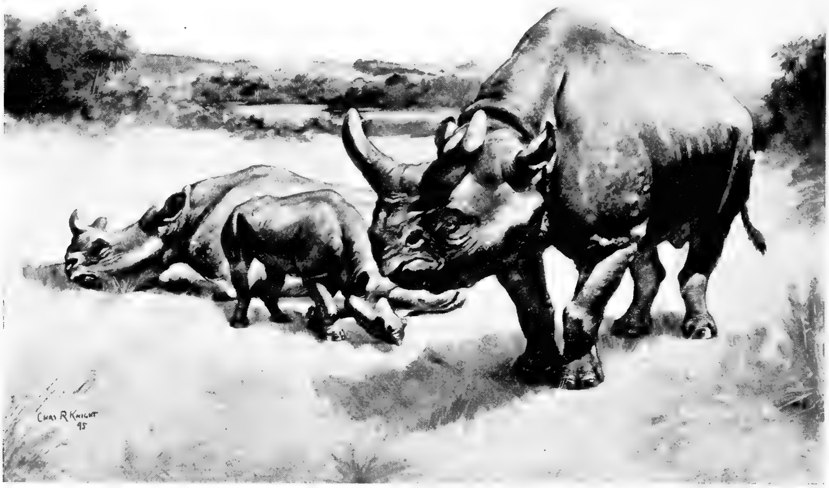
DURING THIS AGE THE REPTILES APPEARED, FLOURISHED GREATLY, AND DECLINED AT ITS CLOSE TO THEIR PRESENT IMPORTANCE. THE MAMMALS APPEARED WELL DOWN IN THIS AGE BUT REMAINED SMALL AND SCARCE UNTIL ITS END.

	PERIODS		FORMATIONS	THICKNESS	CHARACTERISTIC ANIMALS
AGE OF MAMMALS	EOCENE		TORREJON PUERCO	800′	MAMMALS IN LARGE NUMBERS TRUE LIZARDS and SPHENODONS ALLIGATORS and CROCODILES TURTLES NUMEROUS BONY FISHES (TELEOSTS)
AGE OF REPTILES	CRETACEOUS	UPPER	LARAMIE	1000′ 5000′	CARNIVOROUS DINOSAURS HERBIVOROUS DINOSAURS HORNED HERBIVOROUS DINOSAURS NUMEROUS SMALL MAMMALS LAST PLESIOSAURS FIRST SOFT SHELLED TURTLES MODERN TAILED AMPHIBIANS (SALAMANDERS)
			MONTANA	1200′ 8700′	BIRDS, PROBABLY TOOTHED. PTERODACTYLS, TOOTHLESS MOSASAURS and PLESIOSAURS GIGANTIC MARINE TURTLES DOLICHOSAURIAN LIZARDS SHARKS CAT-FISH, STURGEONS and GAR PIKES
			COLORADO	1000′ 3000′	TOOTHED BIRDS TOOTHLESS PTERODACTYLS DINOSAURS MOSASAURS and PLESIOSAURS LARGE MARINE TURTLES BONY FISHES (TELEOSTS) SHARKS GANOID FISHES.
			DAKOTA	400′ 5000′	FIRST SNAKES TURTLES
		LOWER	COMANCHE WEALDEN POTOMAC	300′ 2600′	TRUE LIZARDS and DOLICHOSAURS HERBIVOROUS DINOSAURS (IGUANODONTS) CARNIVOROUS DINOSAURS (MEGALOSAURS) PTERODACTYLS, TOOTHED and TOOTHLESS MOSASAURS ICHTHYOSAURS and PLESIOSAURS CROCODILES. TURTLES. SHARKS and GANOID FISHES CHIMÆROID FISHES
	JURASSIC	UPPER	PURBECK	1500′ 4000′	PRIMITIVE MAMMALS (MARSUPIALS, INSECTIVORES and MULTITUBERCULATES) CARNIVOROUS DINOSAURS (CERATOSAURUS) HERBIVOROUS DINOSAURS (ATLANTOSAURUS) TURTLES. PTERODACTYLS
		MIDDLE			FIRST BIRDS WITH TEETH (SAURURÆ) ICHTHYOSAURS (TOOTHED and TOOTHLESS) PLESIOSAURS PTERODACTYLS (TOOTHED)
		LOWER	STONESFIELD SLATES (ENG) LIAS		SMALL PRIMITIVE MAMMALS LONG NOSED CROCODILES (TELEOSAURS) ICHTHYOSAURS and PLESIOSAURS FIRST HERBIVOROUS DINOSAURS TURTLES. PTERODACTYLS SHARKS and CHONDROSTEAN FISHES
	TRIASSIC	UPPER	RHAETIC RICHMOND COAL-BEDS and CONN. and NEW JERSEY KEUPER	3000′ 6000′	REPTILE-MAMMALS (DROMATHERIUM, TRITYLODON, MICROLESTES) FIRST CARNIVOROUS DINOSAURS LAST LABYRINTHODONTS PRIMITIVE CROCODILES (BELODON) FIRST TURTLES and PTERODACTYLS FIRST TELEOST or BONY FISHES SHARKS, CHONDROSTEAN and LUNG FISHES
		MIDDLE			PLESIOSAURS (NOTHOSAURS) FIRST ICHTHYOSAURS (MIXOSAURUS) PLACODONTS
		LOWER	BUNTER		LARGE AMPHIBIANS (LABYRINTHODONTS) FIRST PLESIOSAURS (NOTHOSAURS)
AGE OF AMPHIBIANS AND COAL PLANTS	PERMIAN			600′ 1000′	FIRST REPTILES (COTYLOSAURS. PROGANOSAURS and PELYCOSAURS) PRIMITIVE AMPHIBIANS (STEGOCEPHALIA SHARKS. LUNG FISHES. CHONDROSTEAN and CROSSOPTERYGIAN FISHES
	CARBONIFEROUS				PRIMITIVE AMPHIBIANS (STEGOCEPHALIA, MOSTLY SMALL SPECIES) PRIMITIVE SHARKS and LUNG FISHES CHONDROSTEAN and CROSSOPTERYGIAN FISHES


THE AGE OF MAMMALS
CENOZOIC, OR TERTIARY AND QUATERNARY.
WESTERN LAKE BASINS and CHARACTERISTIC MAMMALS
THE TERTIARY FORMATIONS ARE REPRESENTED IN WESTERN AMERICA BY A SERIES OF DEPOSITS FORMED ON THE BOTTOMS OF SUCCESSIVE FRESH WATER LAKES. THEIR TOTAL THICKNESS IS NEARLY 12000 FEET, REQUIRING PROBABLY TWO OR THREE MILLION YEARS TO FORM
IN THE SEDIMENTS OF THESE LAKES WERE BURIED THE REMAINS OF MANY OF THE ANIMALS WHICH LIVED AROUND THEIR SHORES, LEAVING THUS A RECORD OF THE SUCCESSIVE SPECIES WHICH INHABITED THE LAKE REGION
PERIODS
LAKE BASINS
CHARACTERISTIC MAMMALS
AGE OF MAMMALS
RECENT AND PLEISTOCENE
EQUUS AND MEGALONYX
150
ELEPHANTS LAST MASTODONS
LAST GROUND SLOTHS LAST SABRE TOOTH TIGERS
CAMELS ONE TOED HORSES CAVE BEARS
PLIOCENE
BLANCO AND PALO DURO
150
GROUND SLOTHS CAMELS ONE TOED HORSES
LOUP FORK
400
MASTODONS TRUE HORNLESS RHINOCEROSES
DEER FIRST PRONG HORN ANTELOPES
DEEP RIVER
150
MIOCENE
HORNLESS AND TWIN HORNED RHINOCEROSES
JOHN DAY
(OREGON, NEVADA)
1000
LAST ELOTHERES OREODONTS
PRIMITIVE CAMELS PRIMITIVE DEER
RODENTS DOGS WOLVES FOXES
CATS SABRE TOOTH TIGERS
OLIGOCENE
WHITE RIVER
(NEV. S.DAK. N.DAK. COL. CANADA)
1000
HYOPOTAMIDS PROTOCERAS
LAST CREODONTS DOGS AND CATS
ELOTHERES CURSORIAL RHINOCEROSES TAPIRS
FIRST THREE TOED HORSES MESOHIPPUS
SWIMMING RHINOCEROSES AMYNODONTS
LAST TITANOTHERES OREODONTS ABUNDANT
FIRST TRUE HORNLESS RHINOCEROSES
(UTAH)
800
PRIMITIVE RHINOCEROSES AND AMYNODONTS
TITANOTHERES ELOTHERES CREODONTS
FIRST CAMELS FIRST OREODONTS TAPIRS
FOUR TOED HORSES PRIMATES RODENTS
LAST UINTATHERES
UINTATHERES.
TITANOTHERES
PRIMITIVE RHINOCEROSES HYRACHYUS
FIRST ELOTHERES ACHÆNODON
BRIDGER
(WYOMING, UTAH)
2000
LARGE CREODONTS MESONYX
FOUR TOED HORSES OROHIPPUS
LAST PRIMITIVE GROUND SLOTHS
PRIMATES RODENTS BATS LAST TILLODONTS
EOCENE
WIND RIVER
WYOMING
800
LAST CORYPHODONS FIRST UINTATHERES
FIRST TITANOTHERES LAST CONDYLARTHS
CREODONTS RODENTS BATS TILLODONTS
AMBLYPODS CORYPHODON
CONDYLARTHS PHENACODUS
WASATCH
WYOMING NEW MEXICO
2000
CREODONTS OR PRIMITIVE CARNIVORES
RESEMBLING CATS DOGS AND BEARS
FIRST RODENTS
TILLODONTS INSECTIVORES
PRIMITIVE GROUND SLOTHS
TORREJON
300
PUERCO
500
AGE OF REPTILES
LARAMIE
5000
CRETACEOUS

much more nearly known. The estimates given on page 5 are based on the very careful study of the subject made by C. D. Walcott, the present Director of the U. S. Geological Survey. In concluding his discussion Dr. Walcott stated his belief that the duration of geological time (the entire period included in this table) might be measured by tens of millions of years, but not by single millions or by hundreds of millions."

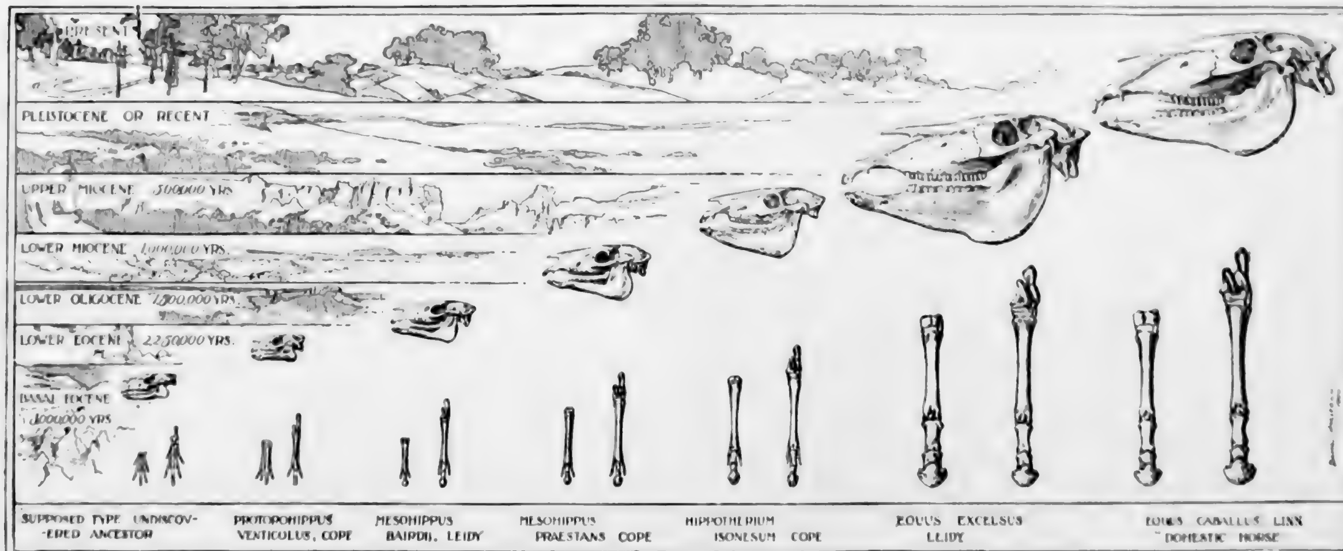
The most ancient of the extinct animals shown here are the creatures of the *Age of Reptiles*, such as the Dinosaurs, or great land reptiles, Mosasaurs, or great marine lizards, Ichthyosaurs, or fish-lizards, and other smaller animals. These are millions of years old. Some of the Dinosaurs are the largest known land



RESTORATION OF TITANOTHERIUM, AN EXTINCT HOOFED MAMMAL OF WESTERN AMERICA
The picture shows a bull, a cow and a calf
From the original watercolor, based on mounted skeleton and skulls in American Museum.

animals, longer than the width of the exhibition hall, and so tall that if they were standing on all fours their backs would reach within a few feet of the ceiling.

The greater part of the specimens are *Mammals*, or animals



EVOLUTION OF THE HORSE.—SKULL, FOREFOOT AND HIND FOOT

Stages of progress in the Ancestors of the Modern Horse. The diagram was based entirely on specimens in the American Museum

(From "Animals of the Past" by F. A. Lucas. By permission of McClure, Phillips & Co.)

EVOLUTION OF THE HORSE.—FEET

Photograph of the series of fore and hind feet in the American Museum, illustrating the Ancestry of the Horse

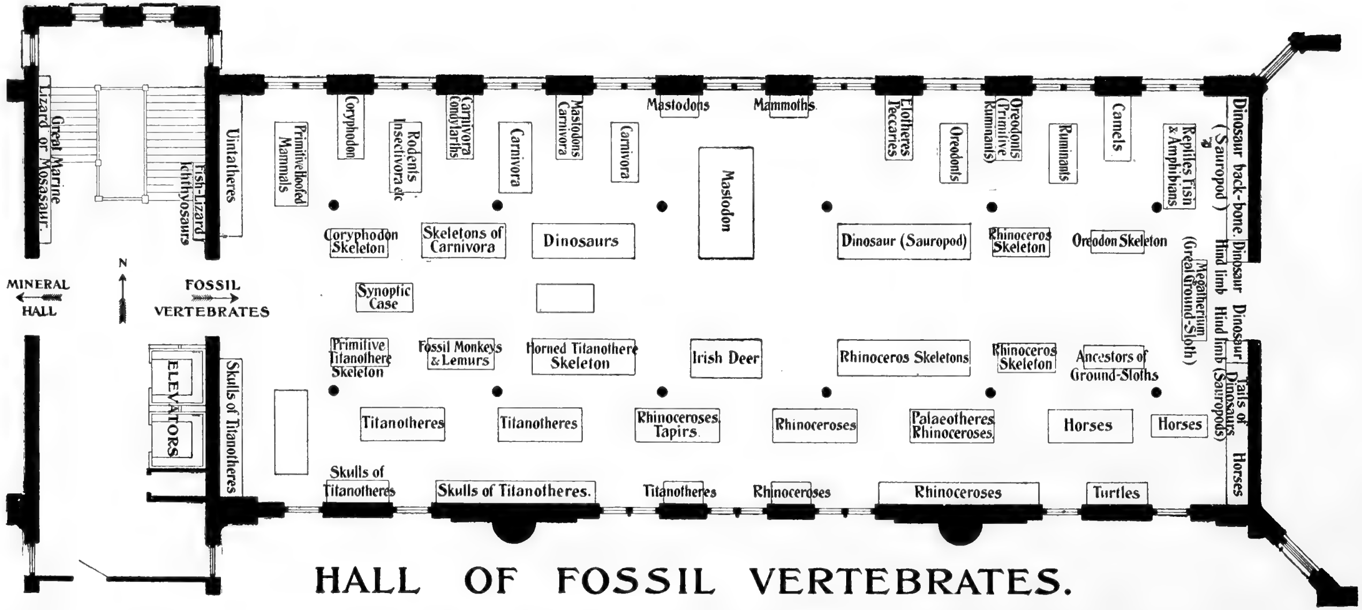
which suckle their young, including most four-footed beasts. Most of them lived during the Tertiary period, or *Age of Mammals*, and are hundreds of thousands of years old, ranging from perhaps three million years down; these lived long before man had appeared on the earth. A few, including the Mastodon, Mammoth, Megatherium, Irish Elk, One-toed Horse and others, are of the latest geological age, the Quaternary, or *Age of Man*, and, while tens of thousands of years old, were contemporaries of the earliest human beings.

Many of the extinct animals are allied to those which are still living and are called by the common names of their modern relatives. Thus we have extinct Horses, Rhinoceroses, Tapirs, Camels etc. Other races have died out completely and are not related to any living animals. *For these there is no popular name*, and we have to coin a name from their Latin or Greek scientific name, calling them "Titanotheres," "Dinosaurs" etc.

Instances of Evolution.

The best example of the evolution of a race of animals is shown in the southeastern corner of the hall. Here is exhibited the *Ancestry of the Horse*, the specimens from successive geological strata showing how the Modern Horse has descended from diminutive ancestors with four toes on each forefoot and three on each hind foot, and with teeth and other parts of the skeleton different from those of their modern representatives.

Almost equally complete, although less familiar, is the series illustrating the *Ancestry of the Camel*, which may be found on the north side of the hall near the east end. These animals, like the Horses, evolved from small and primitive ancestors to large and highly specialized descendants, and then became extinct in their former home, the broad and arid plains of western America, before the advent of civilized man, but survived to modern times in other parts of the world. Less complete series are the skulls and skeletons illustrating the ancestors of Titanotheres and the ancestors of Rhinoceroses. These are ranged along the south side of the hall beginning at the entrance.



HALL OF FOSSIL VERTEBRATES.

Plan of Present Arrangement of Cases-January 1902.

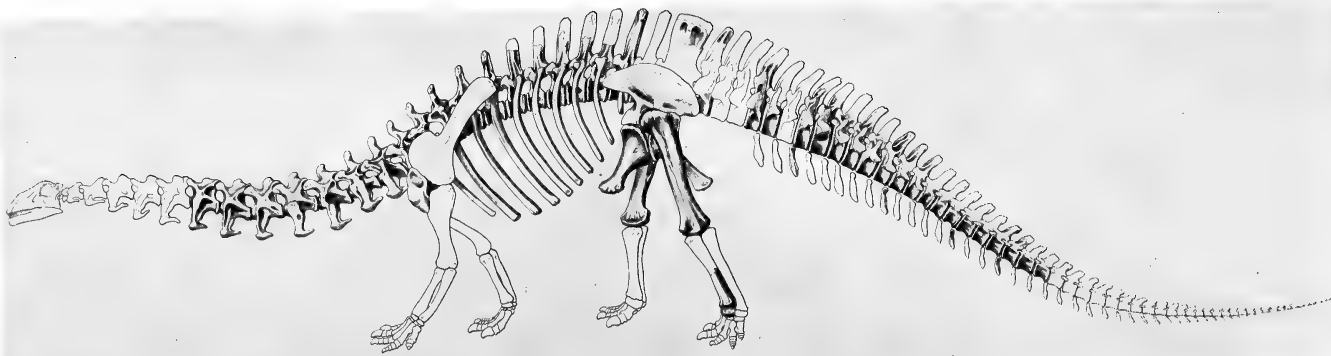
All these series have been placed according to geological age. The most ancient specimens, found in the lowest rock-strata, and hence representing the earliest stage of evolution, are placed first in the series. The most recent ones, found in the uppermost rock-strata, and representing the final stage of evolution of the race, are placed last. Arranging the species of a race from each stratum in the order of the age of the strata, we find that they show a regularly progressive change from the most ancient to the most recent. At no point in a given series can we draw a line and say: This is and that is not, a horse—or a camel—or a rhinoceros. The visitor, therefore, can demonstrate for himself the evolution of the race of Horses or Camels or Rhinoceroses, within certain limits. Of the evolution of Man we have no satisfactory illustration from fossils.

It should be observed that the evolution of a race consists mainly in the adaptation of the structure of the animals to particular surroundings and habits of life. There is also a universal progress in intelligence, the more ancient animals having relatively smaller brains than their successors.

ARRANGEMENT OF THE HALL.

Fossil Mammals.

On the north side of the hall next the entrance are arranged the Amblypods, ancient hoofed animals long ago extinct, unlike any living animal, although suggesting elephants, rhinoceroses, hippopotami and bears in different parts of the body (skeletons of *Pantolambda* and *Coryphodon*, skulls of *Uintatherium*). Next to them are the Condylarths, the most ancient of Hoofed Mammals, chief among them the *Phenacodus* skeleton, well known to students and figured in most geological text-books as the prototype of the Hoofed Mammals. Next to these are the Carnivora, or flesh-eating mammals, of which four fine skeletons are placed in the large "A"-case. Then come the Insectivora, or insect-eaters, and Rodents, or gnawers, represented by small and incomplete specimens. Then the Elephants (*Mastodon* skeleton, skulls of mastodons and mammoths) and the various kinds of Artiodactyls, or Cloven-hoofed animals, which are allied to modern

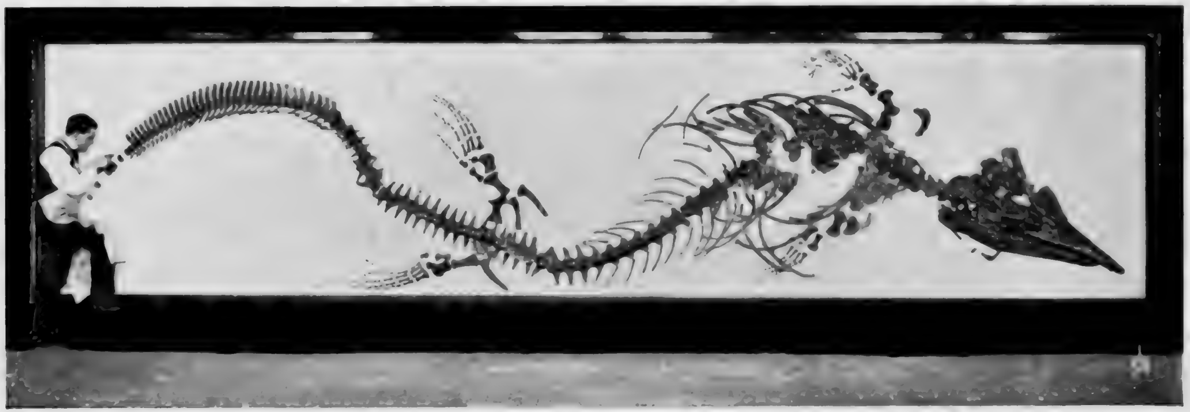


SKELETON OF BRONTOSAURUS

RESTORATION OF THE SKELETON OF A DINOSAUR, OR GIANT REPTILE

$\frac{1}{100}$ Natural Size. Modified from restoration by Prof. O. C. Marsh

The shaded portions represent the bones preserved in specimen No. 460 of the American Museum collection



PHOTOGRAPH OF THE SKELETON OF THE GREAT MARINE LIZARD IN THE AMERICAN MUSEUM

pigs and peccaries, camels, deer, sheep and cattle. Four skeletons and numerous incomplete specimens represent these last.

The south side of the hall is devoted chiefly to the Perissodactyls or Odd-toed Hoofed Mammals. First come the Titanotheres, an extinct group, once abundant in North America, whose evolution is here illustrated by two skeletons and a series of skulls; then the Rhinoceroses, also abundant in North America in former geological epochs, represented here by six complete skeletons and a large series of skulls; after these the Horses, whose evolution is illustrated by two skeletons and many skulls and feet. At the eastern end of the hall is a cast of the skeleton of the *Megatherium*, or great Ground Sloth, the largest of a singular group of mammals which inhabited South America until the advent of Man in that part of the world.

Fossil Reptiles.

The Dinosaurs, or giant reptiles, have been placed temporarily in two wall cases at the east end of the hall, and in the two high cases to the north of the centre aisle. Small models of restorations of three kinds of dinosaur will be found in an "A"-case near the east end of the hall, near the centre aisle.

These were the great terrestrial vertebrates of their day, the *Age of Reptiles*, and they assumed an extraordinary variety of forms, but all had long hind limbs and a long and massive tail. Some of the Sauropods (*e. g.*, *Brontosaurus*, *Diplodocus*, *Morosaurus*), four-footed, long-necked, herbivorous, probably amphibious, were beyond comparison the largest animals that ever trod the earth and can be compared in size only with the modern whales. Incomplete skeletons of these monstrous beasts are shown in this hall. Others, the Megalosaurs, were two-footed, carnivorous, preying on the clumsy giants (Sauropods) with which their remains are found associated in the rock. Others again, the Stegosaurs and Ceratopsians, or armored dinosaurs, were short-necked quadrupeds, massively proportioned, with back and tail covered by heavy bony plates and spines. Another group, the Ornithopods or Iguanodonts, long-limbed bipeds — or rather tripeds, for the long and massive tail formed a third support,—

had broad, flattened, horny bills like some gigantic duck. The knowledge of these strange animals has been gained chiefly from fragmentary specimens and has been hindered not a little by the —to our eyes—strange and inappropriate combinations of form. It is only within the last few years that complete or nearly complete skeletons have been found, and the preparation for exhibition of those possessed by this Museum is not yet finished.

RESTORATION OF THE FOUR-TOED HORSE

Oldest known Ancestor of the Modern Horse; only 16 inches high

Photo from original watercolor by C. R. Knight, based on mounted skeleton in American Museum

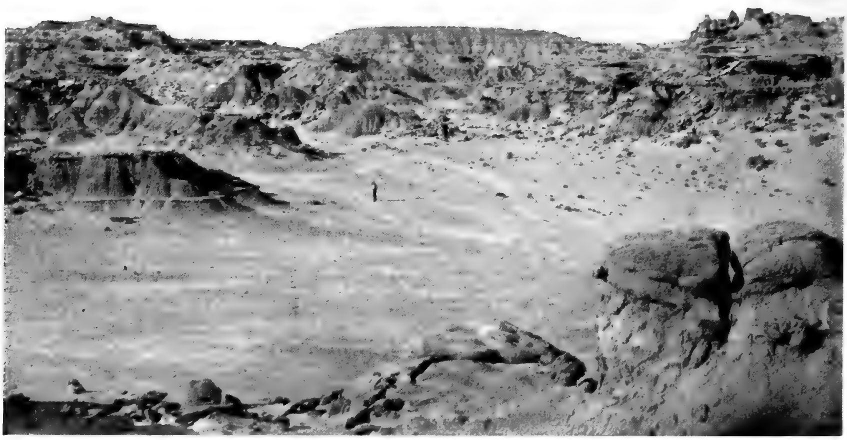
The *Mosasaurs*, or great marine lizards, are represented by the skeleton on the wall of the corridor by the staircase. Three *Ichthyosaur* skeletons are placed on the opposite wall. This corridor will be filled ultimately with specimens of the great marine reptiles of the Mesozoic, or Age of Reptiles, which were in those times the tyrants of the sea, as the contemporary Dinosaurs were the giants of the land.

Fossil Fish.

In the corridor above the skeleton of the great Marine Lizard by the staircase will be found the skeleton of a great fish, obtained from the same geological stratum, and remotely allied to the Tarpon of the Florida coast.

Illustrating the Specimens.

The Watercolor Restorations by Charles R. Knight, done under the immediate supervision of Prof. Henry F. Osborn, the Curator of this Department, mainly based on complete skeletons



SCENE IN THE BAD LANDS OF THE UINTA BASIN—TERTIARY FOSSIL FIELD OF NORTHEASTERN UTAH

exhibited in this hall, show the *probable appearance* of the different extinct animals, according to our best judgment, as indicated by the characters of the skeleton, appearance of their nearest sur-

viving relatives and the habits of life for which the animals seem to have been fitted. The general proportions of the animal, the outlines and form of head and body and, to a great extent, the expression of the features are usually accurately known from the fossil skeleton. The nature of the skin is sometimes but not often certainly known, and the coloring is always conjectural, the palæontologist and the artist having been guided by the coloring of living relatives and the supposed habits of the animal.

The Window Transparencies are enlargements from photographs of the regions where the fossils occur, and generally show the localities where unusually fine specimens in this hall were found. The Expeditions sent out yearly to the Fossil Fields carry with them a photographic outfit, and several hundred characteristic views have been taken, from which these have been selected. The Pillar Cards and general Labels in the cases give detailed information about each group of fossils. One of the cases in the centre of the middle aisle illustrates the method by which the fossils are collected and conveyed to the Museum. The Charts at each side of the entrance show the order in which the rock-strata lie, one over another, and the kinds of fossils found in each stratum.

American Museum of Natural History.

WHAT IT IS DOING FOR THE PUBLIC :

Gives free admission to its halls on Wednesdays, Thursdays, Fridays, Saturdays and Sundays.

Provides for free illustrated lectures on Tuesdays and Saturdays.

Provides for free illustrated lectures to teachers on Saturdays.

Provides instruction to school children when accompanied by teachers.

WHAT IT IS DOING FOR ITS MEMBERS :

Gives free admission at all times.

Provides special courses of illustrated lectures.

Gives free use of Library. Issues the Journal.

Distributes Guide Leaflets.

WHAT IT IS DOING FOR SCIENCE :

Maintains exploring parties in various parts of the United States and in :

Siberia, British Columbia, Alaska, Peru,
China, Mexico, Bolivia, Central America.

Maintains scientific publications :

Memoirs—eighteen numbers have been issued.

Bulletin—fifteen volumes have been issued.

Journal—one volume has been issued.

What the Museum Needs.

Additional members.

Increased subscriptions to defray expenses of exploring expeditions.

Funds to make additional groups similar to those in the Bird, Mammal and Ethnology Halls.

Small sums sufficient to preserve the records of the Indians of New York.

Means for collecting and preserving representative examples of animals on the verge of extinction.

Means for collecting fossils and geological specimens.

Membership Fees :

Annual Members,	$ 10.
Life Members,	100.
Fellows,	500.
Patrons,	1,000.

All money received from membership fees is used for increasing the collections.

AMERICAN MUSEUM OF NATURAL HISTORY

The Collection of Minerals

BY

Louis P. Gratacap, A.M.
Curator, Department of Mineralogy

SUPPLEMENT TO AMERICAN MUSEUM JOURNAL
VOL. II, No. 2, FEBRUARY, 1902
Guide Leaflet No. 4

Second Edition, Revised, May, 1904

American Museum of Natural History

THE AMERICAN MUSEUM OF NATURAL HISTORY was established in 1869 to promote the Natural Sciences and to diffuse a general knowledge of them among the people, and it is in cordial coöperation with all similar institutions throughout the world. The Museum authorities are dependent upon private subscriptions and the dues from members for procuring needed additions to the collections and for carrying on explorations in America and other parts of the world.

The membership fees are,

Annual Members..........	$ 10	Fellows..................	$ 500
Life Members............	100	Patrons..................	1000

All money received from membership fees is used for increasing the collections.

The Museum is open free to the public on Wednesdays, Thursdays, Fridays, Saturdays and Sundays. Admittance is free to Members every day.

MORGAN HALL OF MINERALOGY. NO. 404

The Collection of Minerals.

A Guide Leaflet to the Exhibition Halls
of the
Department of Mineralogy
in the
American Museum of Natural History.

By

LOUIS P. GRATACAP, A.M.,
Curator of Mineralogy.

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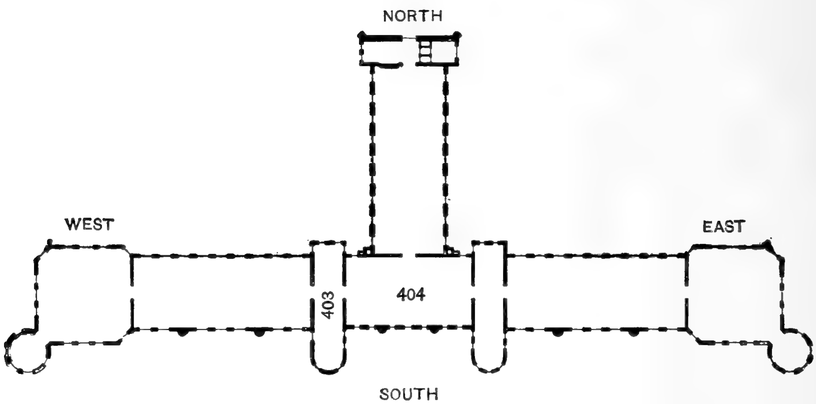


FOURTH FLOOR

Diagram showing location of the Morgan Halls of Mineralogy (Nos. 403 and 404).

THE COLLECTION OF MINERALS.

Introduction.

Minerals, in the broad sense in which science uses the term, include the air, the natural gases, water and the results of change in plant structures, such as coal, oil and resins. More popularly defined, minerals are those stony components of the earth which are to be found in its rocks and their crevices and which present similarity to one another in such characteristics as color, form and hardness. Most observers can easily separate Quartz from Calcite. In making the separation they associate with the idea of Quartz a certain lustre and hardness, a peculiar brittle and irregular fracture and, when the mineral is crystallized, a typical form quite in contrast with the same features in Calcite. A brilliant lemon-yellow crystal, or even a compact mass of Sulphur, is quite distinct in appearance from a greasy, black crystal or nodular piece of Graphite. The obvious physical characters of one are so different from those of the other that the most cursory examination serves to distinguish them as independent substances.

Such striking contrasts, however, do not exist generally in the mineral kingdom, and the observer usually is obliged to give more than a superficial examination to a mineral specimen in order to determine what it is. Most of the common minerals may be differentiated by simple tests with blowpipe and file, but all the rest, and they form by far the largest part of the whole number of species, must be examined by more elaborate chemical and physical means for their exact determination.

The collection of minerals to which this Guide Leaflet is an introduction, though large and comprehensive, cannot be considered an exhaustive representation of the mineral kingdom. It combines, however, in almost equal degrees the elements of

beauty, scientific interest and educational use. The æsthetic influence of a collection of minerals need not be dwelt upon. It is evident that minerals are beautiful in their colors, in their varied forms and, sometimes, in the extreme delicacy of their development.

The History of the Collection.

The growth of the Mineral Collection of the American Museum has been gradual. Its nucleus was the Bailey collection, which contained many of the more common minerals and, while not conspicuous for beauty or completeness, was a fairly representative series serving very well the purpose of an introduction to mineralogy. The Spang collection was purchased in 1891 and more than doubled the number of specimens of minerals in the Museum. This acquisition, furthermore, added a large number of new species, and in many groups increased the variety and richness of form represented.

Previous to the purchase of the Spang collection, a very remarkable group of specimens of Malachite and Azurite (the green and blue carbonates of copper) had been presented to the Museum by the Copper Queen Consolidated Mining Company of Arizona. This unique and very striking assemblage of specimens, together with later additions from the same source, is now installed in the large single case at the north end of the smaller hall (lettered "B" in the diagram).

In the ten years following the acquisition of the Spang collection, many valuable gifts were added to the Museum's series, but preëminence among the exhibition collections in the country was not attained until the close of 1900, when J. Pierpont Morgan, Esq., purchased the Bement collection of minerals and meteorites and presented it to the Museum. This remarkable collection was brought together by Mr. Clarence S. Bement of Philadelphia. It is the result of the careful expenditure of a great deal of money, the purchases having been directed by exquisite taste as well as by scientific judgment. Although the Bement collection contains many rare species, its widespread fame has rested upon the variety of forms representing the com-

moner minerals and the exceptional perfection of the specimens. The present Museum collection is the combination of the material from all these sources, but owing to lack of space the Bement collection only is on exhibition, except in the wall cases.

Classification.

The classification of minerals in an exact sense was impossible as long as mineralogists adopted artificial systems based solely on color, hardness, source, weight or fanciful external resemblances. Only as the science of chemistry developed and as better methods of analysis were devised could a philosophical classification of minerals become possible. To chemical law mineralogy has adhered more and more closely, and while, to some extent, minor groups are founded upon crystallographic identity or similarity, the underlying basis of classification throughout is chemical composition. Minerals of the same chemical type are grouped together, and under that type minerals of similar physical or crystallographic features are arranged in smaller subdivisions. The forms of minerals are their most obvious characteristic. The six-sided prisms of Quartz and Beryl crystals, the rhomboidal or trapezoidal faces of Garnet, the triangular faces of Magnetite and the square faces of Fluorite are unmistakable. Observation at last passed beyond the first stages of curiosity or admiration and, slowly helped by many early students, and rapidly advanced by the genius of two or three, the branch of mineral science known as Crystallography has developed. Crystal form, furthermore, has been found to have close dependence upon chemical composition.

In the development of the nomenclature of the science the form of the names instituted by the ancients has been retained, and the termination *-ite*, derived from the classic Greek *-itis*, meaning *belonging to*, prevails. For example, Hematite, from the Greek word for blood, alludes to the red color of one mineral; Chlorite, to the green color of another, and Siderite, from the Greek word for iron, has reference to the chemical nature of a third. Several names which are exceptions to the rule, such as

SULPHUR FROM CIANCIANI, ITALY

Garnet, Idocrase, Quartz, Mica, Gypsum, Corundum and Spinel, have been so long in use that, like the names of the metals and elements, they must be retained.

According to chemical composition, therefore, the following principal subdivisions of minerals have been established:

I. The Native Elements.

II. The Arsenides, Sulphides, Antimonides, Sulph-arsenides, Sulph-antimonides and similar compounds.

III. The Haloids.

IV. The Oxides, anhydrous and hydrous.

V. The Oxygen-salts, such as Carbonates, Silicates, Phosphates, Columbates, Tantalates, Sulphates and Nitrates.

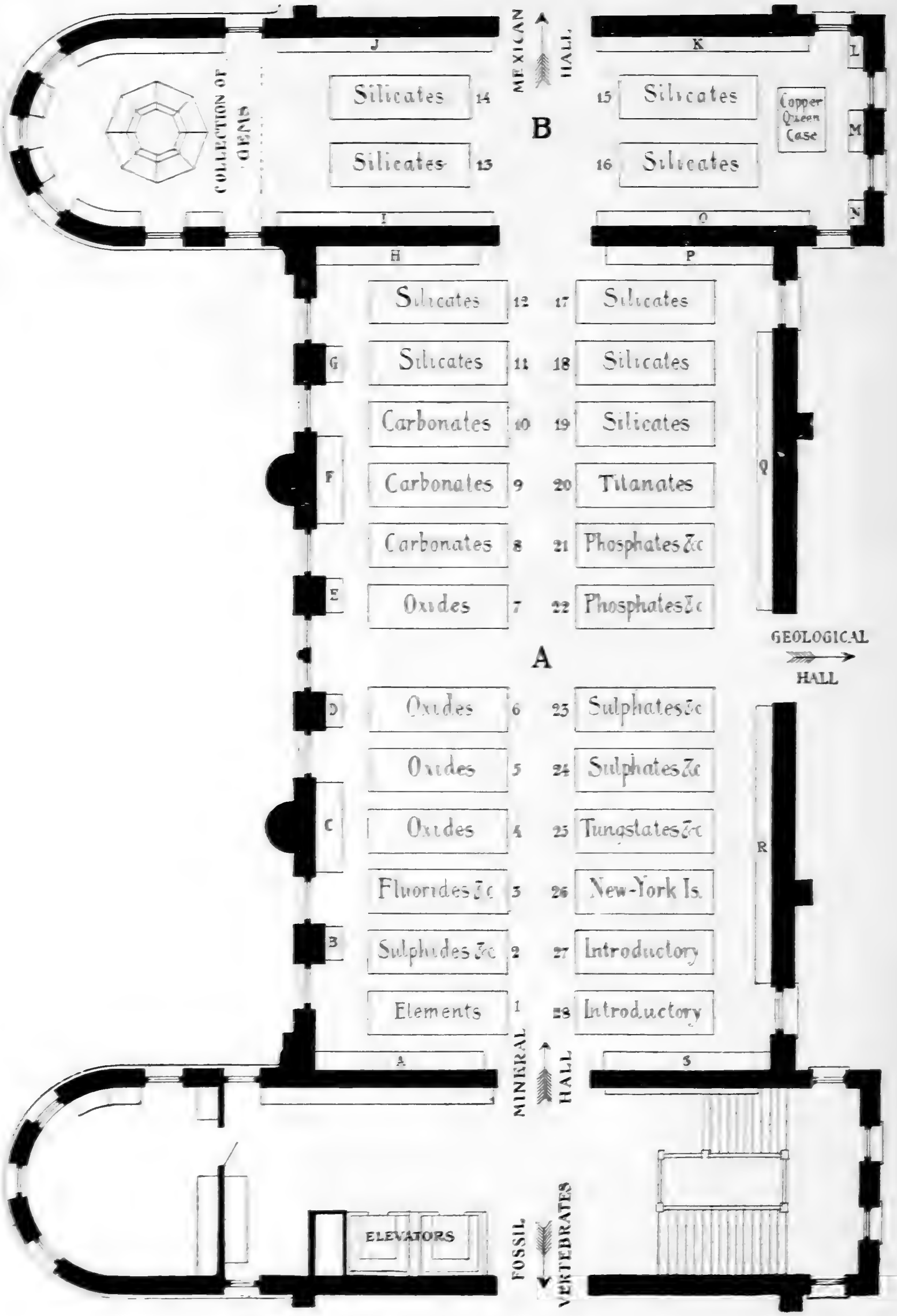
VI. The Hydrocarbons.

This system is almost universally used to-day, with changes, however, more or less material in the succession and interpretation of its various parts, and is practically the production of the last century.

Owing to the early activity of chemical agencies and the still continuing energy of oxygen, a gas which is constantly attacking uncombined elements, the list of Native Elements, as at present known, is much shorter than the list of elements known to chemistry, a large number of them being precluded from any independent existence whatever through their strong affinities for other substances. The mineralogist finds, however, in the portions of the earth accessible to him, a small list of native elements, of which six, at the most, are characteristically uncombined, while the remainder, about fifteen in number, are found native only under exceptional conditions, and one of them, iron, is particularly interesting because its most frequent occurrence is in the form of meteorites.

Guide to the Collection.

The collection of minerals is exhibited in two halls on the fourth floor of the Museum, marked "A" and "B" on the diagram, and is displayed in two sections, the wall case and the desk case exhibits. The wall cases contain those specimens which are



PLAN OF HALLS, DEPARTMENT OF MINERALOGY

too large for the desk cases, but the arrangement in the two series is the same. The systematic series in the desk cases is naturally far more complete than that in the wall cases. The specimens are arranged in accordance with the classification given in the sixth edition of Dana's System of Mineralogy, and the series in the desk cases begins at the left of the entrance to Hall A. It is intended to be studied from left to right along each side of every case, so that one advances from west to east along the south side of the hall, enters the small hall, B, and returns along the north side of the large hall to the end of the series at Case 25. Case 27 contains a collection of the minerals of New York and vicinity, and Cases 27 and 28 contain introductory series presenting the chemical and physical features of minerals, together with explanatory tables and photographs. The meteorites of the collection are now to be found in Cases 25 and 27, but they are soon to be arranged by themselves in cases along the center of the hall. At the head of every scientific subdivision will be found a statement, called here a "Rubric," detailing the principal members of the group, and giving their chemical composition and system of crystallization.

In the Museum collection the Sulphurs, Golds and Coppers are the most striking examples of the Native Elements.

The Sulphur specimens (see Desk Case 1 and Wall Case A) arrest attention on account of their beauty and perfect preservation. The crystallographic habit of the mineral is well known, steep pyramids beveled by the narrow planes of more obtuse pyramids, generally broad basal pinacoids, prisms, domes, hemipyramids and frequent sphenoids. An examination of the crystals will generally reveal upon the large brilliant faces curiously wrinkled and clouded surfaces which, under a magnifying glass, show densely crowded pits and irregular etchings. The sulphur deposits of the earth usually are found in connection with gypsum beds or near active or extinct volcanoes. The sulphur has been produced by separation from sulphuretted hydrogen. The mineral is found in large deposits in Wyoming, Nevada, southern Utah, and California.

Particularly choice are the specimens of Gold. The mineral is

shown here (Desk Case 1) in sheets like rolled metal; in plates, with crystallized edges; in braided filaments made up of minute octahedrons; in grouped octahedrons with hollow faces; in twisted plates frequently attached to quartz, around which it curls like some irregular yellow flower. Gold, from an elongation of the octahedron, assumes deceptive forms, while cavernous, skeleton and pitted crystals, peculiar distortions, reticulated and tree-shaped groups with spongy masses and rounded water-worn nuggets are common natural appearances of this precious metal.

Copper (Desk Case 1) is of especial interest, on account of the beautifully crystallized specimens in which it occurs. Most of our specimens have come from the remarkable deposits of Native Copper in the Lake Superior region of Northern Michigan. They exhibit the characteristic crystal forms of the metal, sprigs and branching crystals, twins and massive plates, the common tetra-hexahedron, cubes and superimposed octahedrons. Here will be found also examples of Copper and Silver which have been welded together by nature.

The next group of minerals is that comprising the Sulphides, Selenides and Tellurides of the metals and semi-metals, and the Arsenides and Antimonides of the metals, which are again succeeded by the so-called Sulpho-salts, in which the union of sulphur with arsenic or antimony is regarded as an acid, chiefly forming compounds with the bases, copper, silver, lead, iron, zinc and mercury. The great variety and number of mineral species resulting from the combinations thus made possible, are for the most part the source of many useful metals, and these combinations characterize the veins, crevices, fissures, caves and beds of mining regions.

One of these, Stibnite, the sulphide of antimony, is a valuable ore (Desk Case 1, Wall Case A). This species affords the mineralogist very beautiful, lustrous, well-terminated prismatic crystals, usually clustered in radiating groups. The striking specimens here displayed, together with many others which have supplied the cabinets of the world, were found at Mt. Kosang near Seijo, province of Iyo, Shikoku Is., Japan. In their size and beauty and

in the complexity of their forms, they surpass the specimens of the same species from all other localities. They increased the number of known crystalline planes of Stibnite from forty-five to eighty-five. Galenite, the sulphide of lead, and Sphalerite, the sulphide of zinc, are represented by beautiful specimens in Desk Case 2 and Wall Cases A and B. Pyrite, the sulphide of iron (Desk Case 2, Wall Case C) is a very common species, and is very strik-

STIBNITE FROM MT. KOSANG, JAPAN

ing on account of its brilliant cubes, dodecahedrons and other crystal forms.

The group of Haloid compounds follows the foregoing division, and is composed of the unions of the elements chlorine, fluorine, iodine and bromine with basic atoms of the metals. The admixture of oxygen produces oxy-salts, and of combined water makes hydrous salts. In this section Fluorite is prominent (Desk

Cases 3 and 4, Wall Cases C, D, E, F). In every large collection this mineral offers a splendid display of colors and associations, and in the Bement collection the series of specimens is especially attractive. From Cumberland, England, there are elongated cubes with attached Calcite crystals; large cubes coated with crystals of Quartz; purple and green cubes densely ruled with fine lines, which indicate oscillations of crystal development;

FLUORITE COATED WITH QUARTZ, CUMBERLAND, ENG.

green cubes from Cornwall with feathery edges of purple, inclusions of black specks and interior colored boundaries (phantoms); also from Brienz, Switzerland, crystals with low scallop-like depressions, pyramidal pits, wrinkling lines and pin-holes, the whole resembling an eroded or half melted ice-block; from Saxony, yellow cubes with Galenite; magnificent pink octahedrons from Switzerland, some of them with blunted or rounded angles made by the planes of the trigonal trisoctahedron.

The Oxides follow the simple compounds of the metals and

QUARTZ FROM MAGNET COVE, ARKANSAS

semi-metals and represent the combination of oxygen with metallic bases. They form one of the most important classes of minerals, and among them are found many of the valuable ores, while Quartz, the oxide of silicon, is the most widely distributed of all the rock-making minerals. In this section, Hematite, Corundum, Spinel, Magnetite, Franklinite and Rutile present some of the most brilliant phases of the mineral world (Desk Cases 6 and 7, Wall Case I).

Quartz, including the chalcedonic forms of silica (Desk Cases 4 and 5, Wall Cases F, G, H, P), is the most prized, the most beautiful and the most varied of all minerals. In color, form and physical constitution, it assumes so many aspects, and the changes from one form to another are so gradual that its complete illustration is almost impossible. It crystallizes in the hexagonal system and usually has the form of a six-sided prism terminated by a pyramid. In the Bement collection its great diversity of development is well shown. Quartz occurs in easily visible particles in granite and many other igneous and metamorphic rocks, in sandstones and quartzites and, as a deposit from aqueous solution, in cavities and crevices in all kinds of rocks. It is the common vein material of mountainous and ore-bearing regions. The absorption of iron and other metallic oxides produces many colors, especially in the various chalcedonic forms of silica.

Following the Oxides are the Carbonates, which form a very important group. The carbonates of lime and magnesia constitute the limestones, while the carbonates of iron and copper are valuable ores. On account of their beauty, many Carbonates,—for example, Marbles, Malachite, Azurite and Mexican Onyx,—take a conspicuous position in a mineral cabinet. The carbonates have been formed by the combination of carbon dioxide with various bases, and the union in many instances has been brought about through the agency of water carrying the carbon dioxide in solution. This has dissolved the base of the salt, the whole being re-deposited afterward from a more or less saturated fluid on a further change of conditions.

In this series the Calcite, Aragonite, Malachite, Azurite, Sider-

ite and Rhodochrosite specimens furnish a long display of forms and colors (Desk Cases 8–10, Wall Cases I, J, K, O).

The Silicates embrace the larger number of mineral species and are the essential components of the crystalline rocks. They are unions of basic elements (the oxides of various metals) with the several forms of silicic acid. The group is subdivided into

AZURITE FROM BISBEE, ARIZONA

two sections: the Anhydrous and the Hydrous Silicates, and these again are broken up into smaller groups based upon similarity of their members to one another in regard to composition, crystallization and optical qualities. Among the Silicates there are several well-marked and compact groups, such as the Feldspars, the Pyroxenes, the Amphiboles, the Garnets, the Sodalites and the Scapolites.

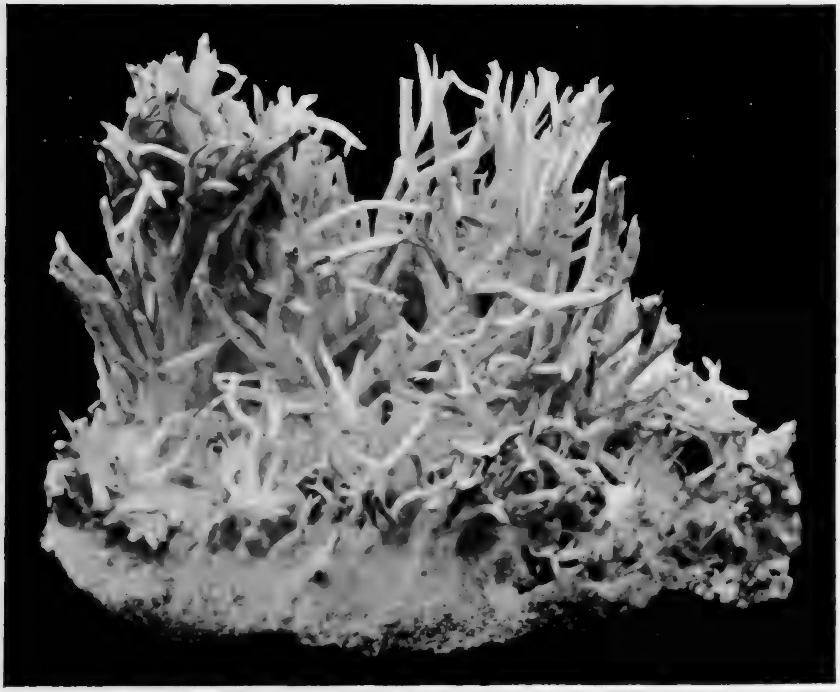
A chemical feature of the greatest importance in the constitution of the silicates is the replacing power of the bases, whereby one or more basic molecules take the place in whole or in part of another in the chemical composition of a mineral. For instance, the sesquioxide of alumina (Al_2O_3) can be replaced by the sesquioxide of iron (Fe_2O_3), except in the feldspars; and, similarly, lime (CaO), magnesia (MgO) and protoxide of iron

CALCITE PSEUDOMORPH AFTER ARAGONITE, CIANCIANI, ITALY

(FeO) are substituted for one another; or any of these can take the place of the oxides of potassium and sodium (K_2O, Na_2O). This replacing process comes prominently into view in Garnet, in which with the same theoretical formula for a very large group the composition of the different varieties is different through the effect of this law. Another, and simpler, instance is the series of compounds connecting Siderite ($FeCO_3$) with Calcite ($CaCO_3$).

Among the silicates may be mentioned Feldspar (Desk Cases 10 and 11, Wall Case R), Pyroxene (Desk Case 11), Amphibole

(Desk Case 12), Beryl (Desk Case 12, Wall Case R), Garnet (Desk Cases 12 and 13 and Wall Case R), Zircon (Desk Case 14, Wall Case S), Topaz (Desk Case 14, Wall Case S), Tourmaline (Desk Cases 15 and 16, Wall Case S), the Zeolites (Desk Cases 16 and 17, Wall Case S), Mica (Desk Case 18, Wall Case Q), Serpentine (Desk Case 19, Wall Case Q), and Talc (Desk Case 19,



ARAGONITE ("FLOS-FERRI") FROM STEIERMARK, AUSTRIA

Wall Case Q). Besides these there is a host of less important species. In Wall Case K may be found a beautiful example of Rhodonite, the silicate of manganese. This interesting mineral has a remarkable development in the zinc area of northern New Jersey, and the exceptional group of prisms illustrated on page 19 is from Franklin in that State.

Beyond the silicates are the salts, or compounds with bases, of the other oxygen acids. Here come in order the Titanates,

Phosphates, Vanadates, Arsenates, Antimonates, Columbates, Tantalates, Borates, Tungstates, Molybdates, Sulphates, Chromates and Nitrates. These are to be found in Desk Cases 20–25 and in Wall Case Q, but it is impossible in this brief review of the collection to dwell upon the interest and beauty of the many species assembled in this section.

Prominent among them, on account of the great beauty of

MALACHITE FROM BISBEE, ARIZONA

its mineralogical development, is the sulphate of barium, or Barite, (Desk Case 23, Wall Case Q). This is a handsome species not remarkable for crystalline variety, but often grouped in sheaves of radiating plates, frequently massive and banded, occasionally globular, fibrous or granular. The crystals are commonly tabular, somewhat modified on the edges, and frequently are tinged yellow, red, green, blue or brown. Barite is found in metallic veins and is of especially common occurrence in lead

RHODONITE FROM FRANKLIN, NEW JERSEY

mines. In recent years extraordinarily beautiful specimens of this mineral have been found in England.

As the visitor completes this preliminary survey of the Hall

BARITE FROM CUMBERLAND, ENGLAND

of Minerals, it is suggested that he review his impressions in the light of these general reflections:

First, that in the inorganic or mineral world the forces governing the molecular arrangement of matter in crystalline forms, and the affinities governing the chemical combination of elements, rule universally;

Second, that the minerals of the earth's surface necessarily are the sole source of all the elements useful in the industries and the arts;

Third, that minerals appeal to our sense of beauty, and are as much to be regarded as objects of artistic appreciation as are the beautiful colors and forms of the animal creation.

BARITE FROM CUMBERLAND, ENGLAND

THE MINERALS OF MANHATTAN ISLAND.

MANHATTAN Island is an area of crystalline rocks, consisting of gneisses, mica-schists, granite, hornblende rock and magnesian limestone (best exposure along the Harlem Ship Canal, Kingsbridge), with a very limited zone of serpentine (10th Avenue and 58th Street). The island has been covered by Drift deposits, sand, gravel, clay and scattered boulders, concealing much of the rock surface. From the original bed rock, especially the numerous granite veins and dikes, and from the mineral masses transported from the north and distributed over its surface, collectors

have gathered many minerals. Most of the species which have been found may be seen in the Collection (Case 27) of the New York Mineralogical Club. This collection is arranged to show, approximately, the minerals of the foliated schistose mica and hornblende rocks, the minerals of the granite veins, dikes and bosses and the minerals of the limestone beds.

Beginning with the minerals of the mica rocks, very fine examples of a yellow to brown Stilbite are noteworthy, the rosettes of flat blades lying upon the scaly surface of the gneiss or schist. With these are remarkable specimens of Chabazite, Epidote, Fibrolite, Harmotone, Heulandite and the interesting little spheres of Sphærosiderite. The hornblende rock follows with superb flattened crystals of greenish Titanite imbedded in the black masses. The view taken by geologists of the hornblende rocks on Manhattan Island now is that they are the changed remains of former igneous intrusions, soft pasty lava-like dikes, entering the island beds. They are often associated with epidote. The hornblende rocks are well exposed near 135th Street and Amsterdam Avenue.

The granite section shows a striking group of minerals, and it is in these granites—mostly veins or dikes—that the collector finds the richer collecting grounds. Here are Allanite (in long crystals as Orthite), Apatite, Beryl, Cyanite, Dumortierite (a rare mineral), Feldspars (Albite, Orthoclase, Oligoclase, Microcline), Micas (Muscovite, Biotite), Garnet (note particularly the superb example from West 35th Street), Magnetite, Monazite (a rare mineral containing cerium, didymium, lanthanum and thorium), Ripidolite, Tourmaline (big, splendid black crystals in Quartz), Wernerite and Xenotime (another rare mineral containing yttrium, erbium, cerium and thorium).

The last group of minerals belongs to the limestone beds, and here are pretty bunches of Smoky Quartz crystals, brown Tourmalines and white Pyroxene (Malacolite) with peculiar veinlets of fibrous Aragonite.

Another area (the serpentine) yields examples of an intermixture of Calcite (Dolomite) and Serpentine, forming a speckled rock called (incorrectly) Ophiocalcite. More striking specimens of this can be seen in Case I of the Geological Hall.

There are several mineralogical surprises in the collection, for example: Galenite (sulphide of lead) in minute cubes on Chabazite, Gypsum in radiating prisms on mica rock, Fluorite (large block from the Subway), Iolite (Pinite), Zircon, Uraninite (the chief mineral containing radium).

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AMERICAN MUSEUM OF NATURAL HISTORY

North American Ruminants

BY

J. A. Allen, Ph.D.

Curator, Department of Mammalogy and Ornithology

SUPPLEMENT TO AMERICAN MUSEUM JOURNAL

VOL. II, No. 3, MARCH, 1902

Guide Leaflet No. 5

Second Edition, Revised, February, 1904

American Museum of Natural History

THE AMERICAN MUSEUM OF NATURAL HISTORY was established in 1869 to promote the Natural Sciences and to diffuse a general knowledge of them among the people, and it is in cordial coöperation with all similar institutions throughout the world. The Museum authorities are dependent upon private subscriptions and the dues from members for procuring needed additions to the collections and for carrying on explorations in America and other parts of the world.

The Museum is open free to the public on Wednesdays, Thursdays, Fridays, Saturdays and Sundays. Admittance is free to Members every day.

The membership fees are,

Annual Members..........	$ 10	Fellows....................	$ 500
Life Members.............	100	Patrons....................	1000

All money received from membership fees is used for increasing the collections.

CONDITIONS IN 1918

It is now sixteen years since this leaflet was printed and many changes have taken place among our big game animals, both those in a wild state and those represented in the Museum. With the exception of the bison, which, owing to strenuous efforts on the part of a few individuals, has increased in numbers, our big game animals have continued steadily to decline. This is especially true of the pronghorn, an animal of very delicate constitution and very difficult to preserve under any conditions. The Virginia deer, on the other hand, can be readily preserved and rapidly increases in numbers wherever granted proper protection. Some of the gaps in the study series have been filled but some still remain.

Owing to the general growth of the collections without corresponding growth of the building, it has not proved practicable to construct groups on the scale of the Bison and the Moose, but a number of groups of a smaller size have been added. These include the Pronghorn Antelope, Roosevelt's Elk, Grant's Caribou, Virginia Deer, Bighorn and Mountain Goat.

There has been some necessary rearrangement of collections, due to lack of room. The boreal mammals have been transferred to the North American Hall and so have the groups of mammals found within fifty miles of New York City.

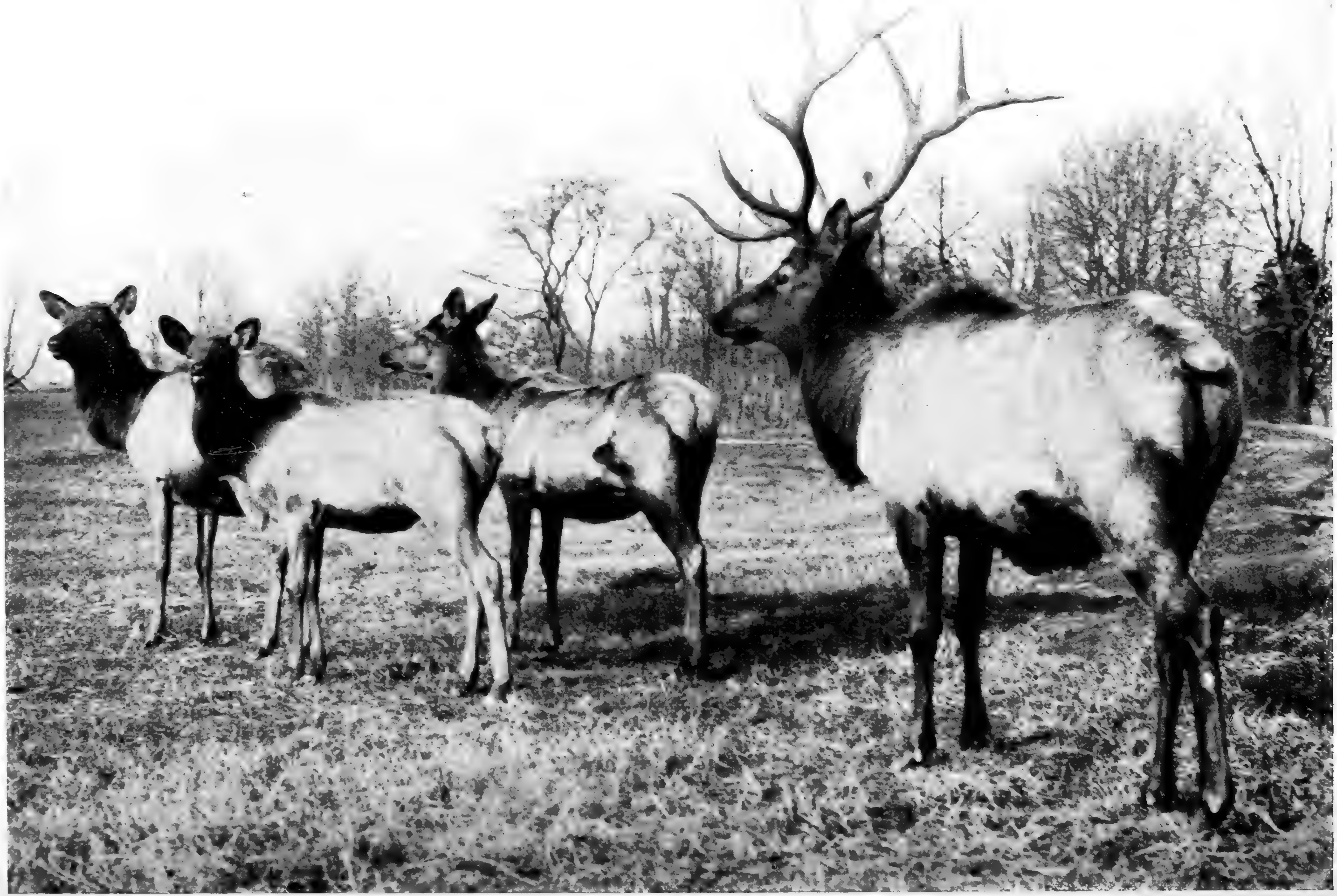

Photo. by E. F. Keller

ELK OR WAPITI. NEW YORK ZOÖLOGICAL PARK

(From negative taken for Department of Public Instruction, American Museum)

North American Ruminants.

A Guide Leaflet to the Collection

in the

American Museum of Natural History.

By

J. A. ALLEN, Ph.D.,

Curator of Mammalogy and Ornithology.

GUIDE LEAFLET No. 5.

SUPPLEMENT TO THE AMERICAN MUSEUM JOURNAL,

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NORTH AMERICAN RUMINANTS.

By J. A. Allen, Ph.D.,

Curator, Department of Mammalogy and Ornithology.

Introduction.

The Ruminants of North America comprise the Deer, the Pronghorn Antelopes, the Bighorn or Mountain Sheep, the Mountain Goats and the Bison or "Buffalo." They are all "game animals," and, like the game animals of all parts of the world, they are, in many instances, rapidly approaching extermination. The Bison, once so abundant on our western plains, is now almost an animal of the past. The Elk or Wapiti Deer has been exterminated over probably nine-tenths of its former range; the Pronghorn, the Virginia Deer and the Mule Deer have also become greatly restricted, as has the Moose. Even the Caribou and the Musk-Ox in the far North are being slaughtered annually by the thousand, and are becoming exterminated over extensive areas where they were formerly abundant.

The partial extermination of large mammals is inevitable, as the country becomes settled, and the land is required for agricultural purposes, but in this country the waste of animal life has been enormous and inexcusable. The Buffalo was slaughtered by the million long before its haunts were needed for settlement, partly for its hide and partly to afford sport for the big-game hunter. The slaughter of the Elk in the trans-Mississippian territory has been almost equally needless and extensive. The Rocky Mountain Bighorn has been wiped out of existence over large portions of its natural range, and now the destruction of the Caribou and Moose in the far North is proceeding with almost incredible rapidity, not only in the regions invaded by the miner and prospector, but also along the Arctic coast for the supply of whale ships with fresh meat. Doubtless some of the strongly marked climatic races of the Deer tribe have been wholly destroyed, with no specimens in our museums to testify to their former existence.

Owing to the large size of these animals and the consequent difficulty and expense of obtaining and preparing them, very few specimens have found their way to museums, and no time should be lost in obtaining such series as will adequately represent them, since it will soon be too late to secure the animals even for museum purposes. A single specimen or a pair of specimens is insufficient for the purpose, since each species varies greatly in color according to season and in other characters according to age and sex. Our large museums owe it to posterity to see that these animals are suitably represented, preferably mounted as groups with their natural surroundings, and in large series for the purposes of research and to draw upon later for exhibition, since it unfortunately happens that specimens exposed to light as museum exhibits quickly deteriorate by fading and from other causes, and eventually require replacement by fresh material.

Horns and Antlers of Ruminants.

The Ruminants are herbivorous, cud-chewing animals; they include the Deer, the Pronghorns, the Antelopes, the Sheep, the Goats and the Ox tribe, and hence nearly all of the mammals most economically important to man. They form two quite distinct divisions according to the nature of their horns, these divisions being known respectively as Solid-horned Ruminants and Hollow-horned Ruminants, and also as Antlered Ruminants and Horned Ruminants. The first section includes the Deer and Pronghorns, and the other the Antelopes and the Sheep, Goat and Ox tribes. The antlers of Deer consist of nearly homogeneous bony tissue, lighter and more porous in structure than ordinary bone; are generally much branched or forked, and are shed and renewed every year. They are secondary sexual organs, usually present only in the male, and when existing in the female, as in the case of the Caribou, they are greatly reduced in size. They are shed soon after the rutting season, and are renewed by a wholly new growth, acquired slowly, so that the fully grown and perfected antler is worn for only a few months. During growth it is enclosed in a soft membrane,

Antlers of Deer.

covered externally with short, thick, velvety fur, which consists of a network of blood vessels which supply nutriment for the growth of the antler. During this stage the antlers are said to be "in the velvet," and are then very sensitive to injury. When fully grown, the membranous covering shrivels and dries up, and falls off in shreds or is rubbed off by the animal.

Horns of Oxen, Sheep, etc.

The horns of the hollow-horned Ruminants are entirely different from the antlers of Deer, in structure as well as in manner of growth. They are usually common to both sexes, as in our domestic cattle, are simple and not branched, and grow continuously throughout the life of the animal, though very slowly after it has reached maturity, and are never shed. They consist of a bony core—an elongated process from the frontal bone—covered with horn, from which the organ takes its name, and which is easily removed by maceration, or through decomposition after the death of the animal. This outer shell is the true horn, the bony core is its support.

The American Pronghorns offer a *quasi* exception to this division of Ruminants into solid-horned and hollow-horned sections. They have the permanent bony horn-core of the hollow-horned division, with an outer horny sheath, which is annually shed and renewed, as are the solid antlers of the Deer tribe. They are, however, usually assigned to the solid-horned or antlered section of Ruminants.

Families of North American Ruminants.

Technically speaking, the Ruminant game animals of North America consist of three distinct families, two of which are represented by several genera, and some of the genera by numerous species. These families are, the Pronghorns, family *Antilocapridæ;* the Deer, family *Cervidæ,* and the Sheep, Goat and Ox tribes, forming the family *Bovidæ.* These will be now passed in review, with special reference to their present representation in the American Museum. The geographical area covered in this connection by the term North America includes the whole North American continent from the Arctic regions to Panama.

Photo. by E. F. Keller

PRONGHORN OR AMERICAN ANTELOPE. NEW YORK ZOÖLOGICAL PARK

(From negative taken for Department of Public Instruction, American Museum)

ANTLERED RUMINANTS.

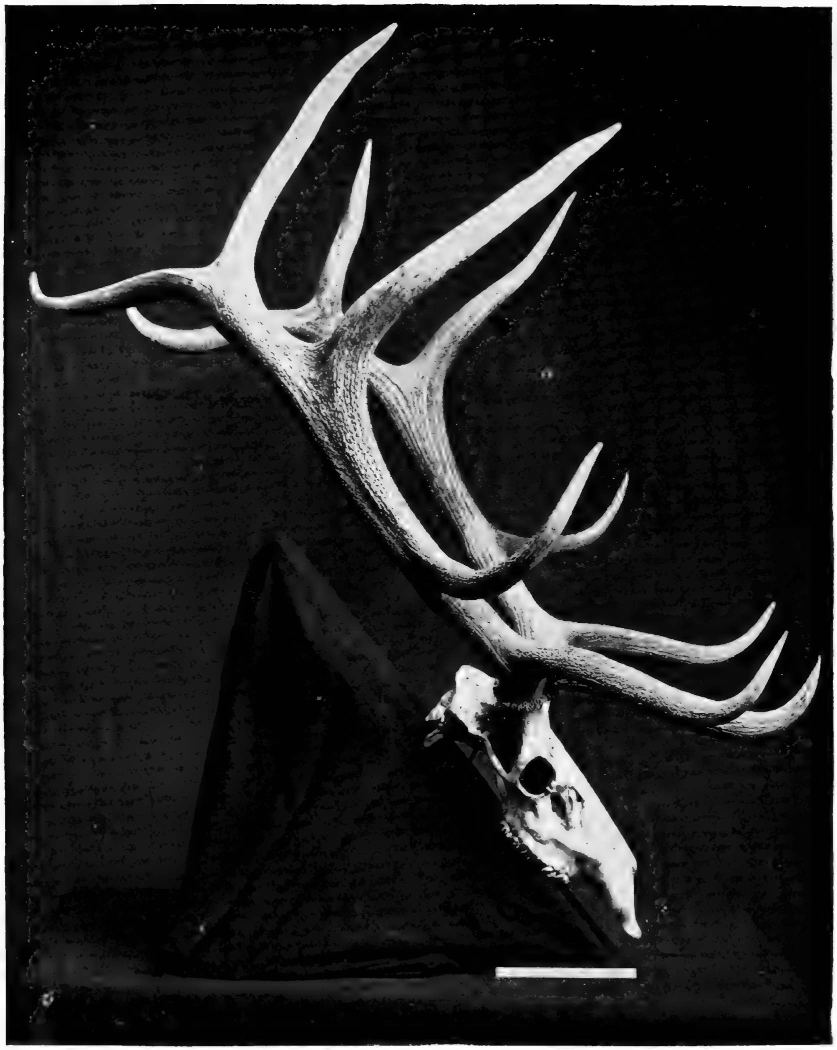
Pronghorn.

The Pronghorns, or Pronghorn Antelopes, or American Antelopes, as they frequently are called, formerly had a range which extended from the Saskatchewan region southward over the plains, parks and portions of the Great Basin region to the tablelands of Mexico, their eastern limit being the eastern border of the Great Plains. Over this vast area they formerly ranged in large herds, numbering hundreds and often thousands of individuals, but they have now disappeared entirely from a large portion of this great region, being found in their former abundance only within comparatively limited districts. Two forms of Pronghorn are now recognized by naturalists—a northern and a southern, the latter at present confined to a small area in Mexico. The Pronghorn, though often called the "American Antelope," is not a true Antelope, as once supposed, but is a distinct family type, found only in North America. It is one of the most beautiful, graceful and agile of American game animals, gentle, and possessed of great curiosity, advantage of which is often taken to secure its destruction. Unless strenuously protected, it will soon whol y disappear from our western mountain valleys and plains.

The Pronghorn is represented in the Museum by a pair of mounted specimens and a mounted skeleton, and in the study collection by a small series of skins and skulls. Owing to the peculiar interest of this very distinct type, it should be elaborately presented to the public as a group, with the proper setting to illustrate its natural haunts.

North American Deer

The Deer tribe consists of five groups, commonly recognized as genera, namely: the Elk, genus *Cervus;* the small Deer of the United States and Mexico, genus *Odocoileus* (recently known, successively, as *Cariacus* and *Dorcelaphus*); several smaller kinds of Deer or Brocket, with unbranched antlers, of the genus *Mazama*, found in southern Mexico and Central America; the Moose, genus *Alces*, with broad palmate antlers, and the Caribou, genus *Rangifer*, of which five or six very distinct forms are known.



ELK OR WAPITI, NORTH DAKOTA
(From Bulletin American Museum, Vol. XVI, 1902, p. 5)

ARIZONA ELK

(From Bulletin American Museum, Vol. XVI 1902, p. 4)

Elk, or Wapiti.

The Elk, or Wapiti Deer, is one of the largest and most stately of the Deer tribe, with very large, branching antlers and a magnificent pose. This animal formerly ranged eastward nearly or quite to the Atlantic coast of the Middle States, but now it practically is extinct east of the Rocky Mountains and is becoming greatly reduced in numbers throughout the western natural parks and valleys, where not many years ago it roamed in large bands. This type of Deer formerly extended southward to the northern border of Mexico, occupying isolated areas wherever the conditions of the country favored its existence. The eastern form probably differed considerably from the animal of the plains and Rocky Mountain region, but how and to what extent it was distinct will never be determined, owing to the entire absence from our museums of specimens from the eastern part of the United States.

Roosevelt Elk.

A darker western form, known as the Roosevelt Elk, is still found in small numbers in the coast ranges of Oregon, Washington and British Columbia. It is much darker in color, and differs somewhat in the character of the antlers from the Rocky Mountain form. A southern form, almost extinct, has been described recently from Arizona, which differs from the others in color and in the form of the antlers. Of the Rocky Mountain Wapiti, the Museum has several poor mounted specimens, a mounted skeleton and several specimens in the study collection, mostly animals which had been in captivity and which have been received from zoölogical gardens. Of the Roosevelt Elk, the Museum recently has purchased a series of five specimens for mounting as a group, but the Arizona form is represented by a single skull. It is very desirable that the mounted specimens should be replaced by better examples, and the Arizona Elk obtained, if possible.

Moose.

The Moose, perhaps the largest of the Deer tribe, being heavier bodied than the Elk, but with less branching though much broader antlers, is found from northern New England, northern Minnesota and Montana northward nearly to the Arctic regions. The Moose of the eastern districts is already represented in the Museum by a group of specimens, ob-

tained mostly in New Brunswick and mounted with great care, the accessories representing an autumn scene in the actual haunts of the animal. This group is one of the most elaborate of its kind in the world as regards the details of construction.

ALASKA MOOSE (ALCES GIGAS)
From mounted specimen in Museum. Andrew J. Stone Expedition

The Moose inhabiting Alaska and the extreme northern portion of British Columbia differs from its eastern representative in its somewhat larger size, darker coloration and more massive antlers. It has been called *Alces gigas*, in reference to

NEWFOUNDLAND CARIBOU (RANGIFER TERRÆNOVÆ)
Mounted specimen in American Museum
(From Bulletin American Museum, Vol. VIII, 1896, pl. x)

KENAI CARIBOU (RANGIFER STONEI)
Mounted specimen in American Museum. Andrew J. Stone Expedition
(From Bulletin American Museum, Vol. XIV, 1901, p. 144)

its large size. The largest antlers have the remarkable spread of seventy-eight inches. The Museum is fortunate in the possession of a good series of this type of Moose, suitable for mounting as a group or as single specimens. For this valuable material we are indebted to the Andrew J. Stone expedition, for the maintenance of which the necessary funds have been generously contributed by friends of the Museum.

Caribou.

The Caribou are even more boreal than the Moose. They range next in size to it and the Elk, and have graceful, slender, profusely branching antlers. They are found from northern New England and British Columbia northward to the Arctic coast, and they occur also in Greenland. While the different varieties present general similarity, they differ greatly in size and in style of antlers, according to the regions they inhabit. The Newfoundland Caribou is an insular form restricted to the island from which it has received its name. It is characterized by short, heavy, much-branched antlers and very light coloration. Of this species the Museum has several mounted specimens, but it is especially desirable that it should be illustrated by a group.

Woodland Caribou.

The Woodland Caribou, as its name implies, inhabits the woodlands of the colder parts of eastern North America. It is a large dark form, with rather stout antlers. The Greenland and Barren Ground Caribou are both small forms, with relatively long but very slender antlers. They are of special interest as representing the most northern type of the Deer tribe, their homes being the treeless Arctic tundra. Neither form is at present well represented in the collection.

Mountain Caribou.

The Mountain Caribou is found in the Rocky mountains from British Columbia northward; it is represented in the mounted collection by a fine adult male. It is one of the largest members of the group, of very dark color and with massive antlers. In Alaska, there appear to be two other phases of this plastic group, one very large and the other small, with small, rather delicately formed antlers. This latter form is now represented by a good series of specimens, lately

obtained by the Stone expedition; they have been mounted in a group, with appropriate accessories, brought from Alaska.

The Deer constituting the genus *Odocoileus* are much smaller, more graceful and more delicately formed than the Caribou and Moose. They are typically represented by the common eastern or Virginia Deer, and are very numerous in species and subspecies, many of which are quite restricted in distribution. Those of the United States fall into three groups, commonly known as White-tailed Deer, Mule Deer and Black-tailed Deer. The White-tailed Deer embrace the Virginia Deer and its related subspecies, of which four or five are now currently recognized, which differ from one another in size and in minor details of coloration. The Deer, like many other animals, decrease notably in general size, and in the size of the antlers, from the north southward, and are thus separable into well-marked races; the Florida Deer, for example, being not much more than half as heavy as the Deer found in Maine and New Brunswick. Another form of the group is found on the plains, another in Texas and still another in Louisiana.

Virginia Deer.

The Mule Deer, so called from the large size of the ears, occupy the middle region of the continent from Canada to Mexico, but are typically represented by the form found in the Dakotas. There are other subspecies in Manitoba, California, Sonora, Mexico and the islands off the coast of California.

Mule Deer.

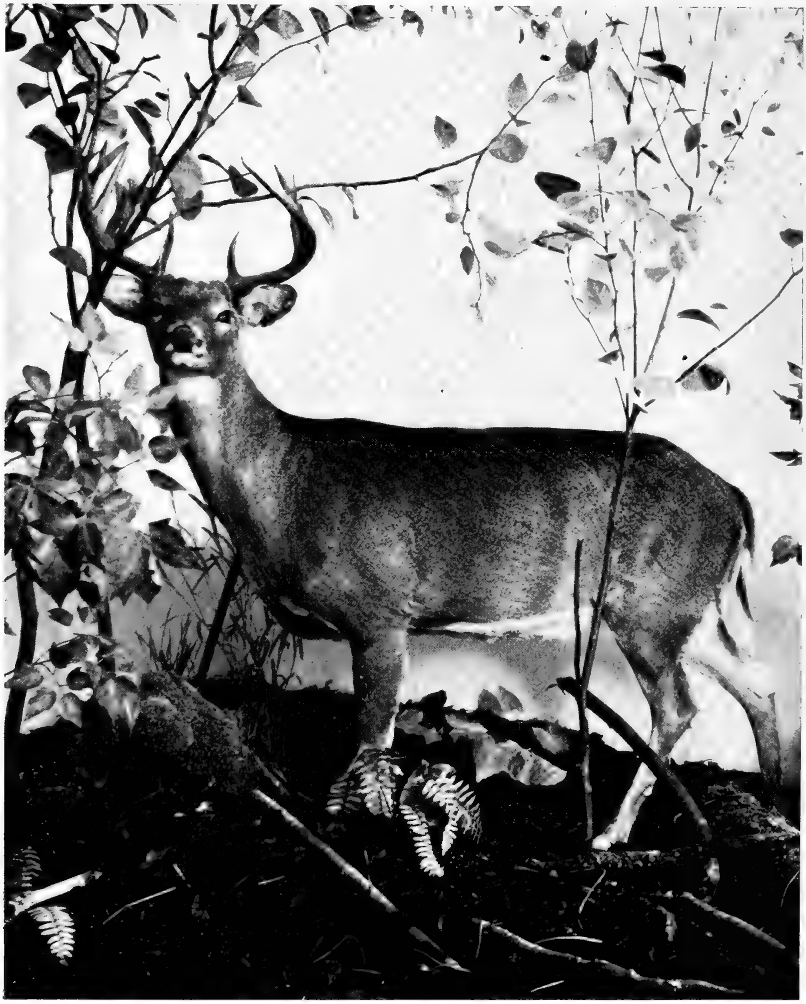
The Black-tailed Deer, found only on the Pacific slope from California northward to Sitka, are represented by a series of forms. On comparing specimens from Sitka with those from Southern California, the differences in size and color are very striking.

Black-tailed Deer.

Besides the Deer already mentioned, five species of this genus are found in Mexico. In comparison with the Virginia Deer they are exceedingly small, with the antlers greatly diminished, being, in fact, miniature representatives of the more northern forms of the genus. In Costa Rica there is another type of small Deer, in which the antlers are

Mexican Deer.

reduced to a single tine only a few inches in length. This Deer belongs to a South American group of the genus *Mazama*, not represented north of southern Mexico.



VIRGINIA DEER
From the group in Local Collection, American Museum

In brief, there are between twenty-five and thirty species of small Deer found in North America, including Mexico, of which

only six are represented in the Museum. Of these the eastern or Virginia Deer is exhibited in a group in the Local Collection, and there are two or three other mounted specimens in the North American collection. The five other species are represented by single specimens, several of them very poorly mounted; consequently, it may be said that, comparatively speaking, the Museum is

Number of Deer in North America.

Photo. by E. F. Keller

MEXICAN DEER. NEW YORK ZOÖLOGICAL PARK

(From negative taken for Department of Public Instruction, American Museum)

almost destitute of the Deer of this extensive group, only a small part even of those found in the United States being shown in the exhibition series.

The Deer are subject to much greater variations due to season than most other large mammals, and vary also greatly with age.

Variations in Deer due to Season.

The young of the Elk and of all the smaller Deer are, at first, bay spotted with white. After a few months they change their dress for one of a more uniform and wholly different tint, while the adults have a summer dress very different from that worn in winter. The summer coat is short and comparatively fine in texture and generally is of some shade of yellowish brown or "fawn color." At the approach of winter this is succeeded by new hair of a bluish cast, which later becomes brownish gray through the addition of the long, coarser hair that forms the winter coat. The exact tint varies with the species, but the fall and winter coats are always very different in general effect from the dress of summer. The summer coat is commonly termed, in hunter's parlance, the "red coat" and the fall dress the "blue coat."

Differences due to Age and Sex.

Besides the differences due to a change of coat with the change of the seasons, there are other differences due to age, as in the size and shape of the antlers, their absence in the females at all seasons, and their presence in the males during a portion of the year, and the very different appearance of the antlers when "in the velvet" and when mature. The Deer thus afford very effective material for Museum exhibits, and quite a series of specimens of the same species is required for its proper illustration. Such series, mounted in groups, with proper settings to show the nature of the diverse haunts characteristic of the different species, afford ample range for the skill of the taxidermist and abundant means for the presentation of attractive museum exhibits, pleasing and instructive to the visitor, and form permanent records of species rapidly passing out of existence.

Horned Ruminants.

Having now passed in review the Deer tribe, we reach the Sheep and Ox tribes. Most prominent of these is the almost extinct American Bison, fortunately well represented in the

AMERICAN BISON
Group in American Museum of Natural History

Museum by skeletons, skulls and skins, in addition to the fine group which forms so conspicuous an exhibit in the North American Hall. Indeed, the Museum is to be congratulated on having not only the finest Bison group in the world, but a large reserve stock of specimens of this rapidly disappearing type, which but a short time ago existed in seemingly

American Bison.

AMERICAN BISON
Cow and calf from group in American Museum
Specimens presented by Col. W. F. Cody

inexhaustible numbers. In the summer of 1871 the author saw on the plains of western Kansas Buffaloes by the hundred thousand, if not by the million. As far as the eye could reach, the plains, on certain occasions, were literally black with Buffaloes.

The hide hunters were already among them, and this was one of the years of their greatest havoc. Three years later these same plains were covered with the bleaching carcasses of these hundreds

STONE MOUNTAIN-SHEEP (OVIS STONEI)
Mounted specimen in American Museum
(From Bulletin American Museum, Vol. IX, 1897, pl. ii)

of thousands of Bisons, from which merely the hides had been removed and the bodies left to rot. In 1873 similar scenes were witnessed in the valley of the Yellowstone, and here again, a few years later, only the carcasses of dead Buffaloes remained,

FIG. 1

FIG. 2

FIG. 1. STONE MOUNTAIN-SHEEP. FIG. 2. ROCKY MOUNTAIN BIGHORN

From mounted specimens in American Museum

(From Bulletin American Museum, Vol. IX, 1897, pl. iii)

together with their well-worn trails, to testify to the former existence of the immense herds seen in 1873. And now, when only a few hundred remain of all the former millions that roamed the central portion of the continent, from Great Slave Lake to Texas, Congress is reported to be considering a bill for the protection of the American Bison!

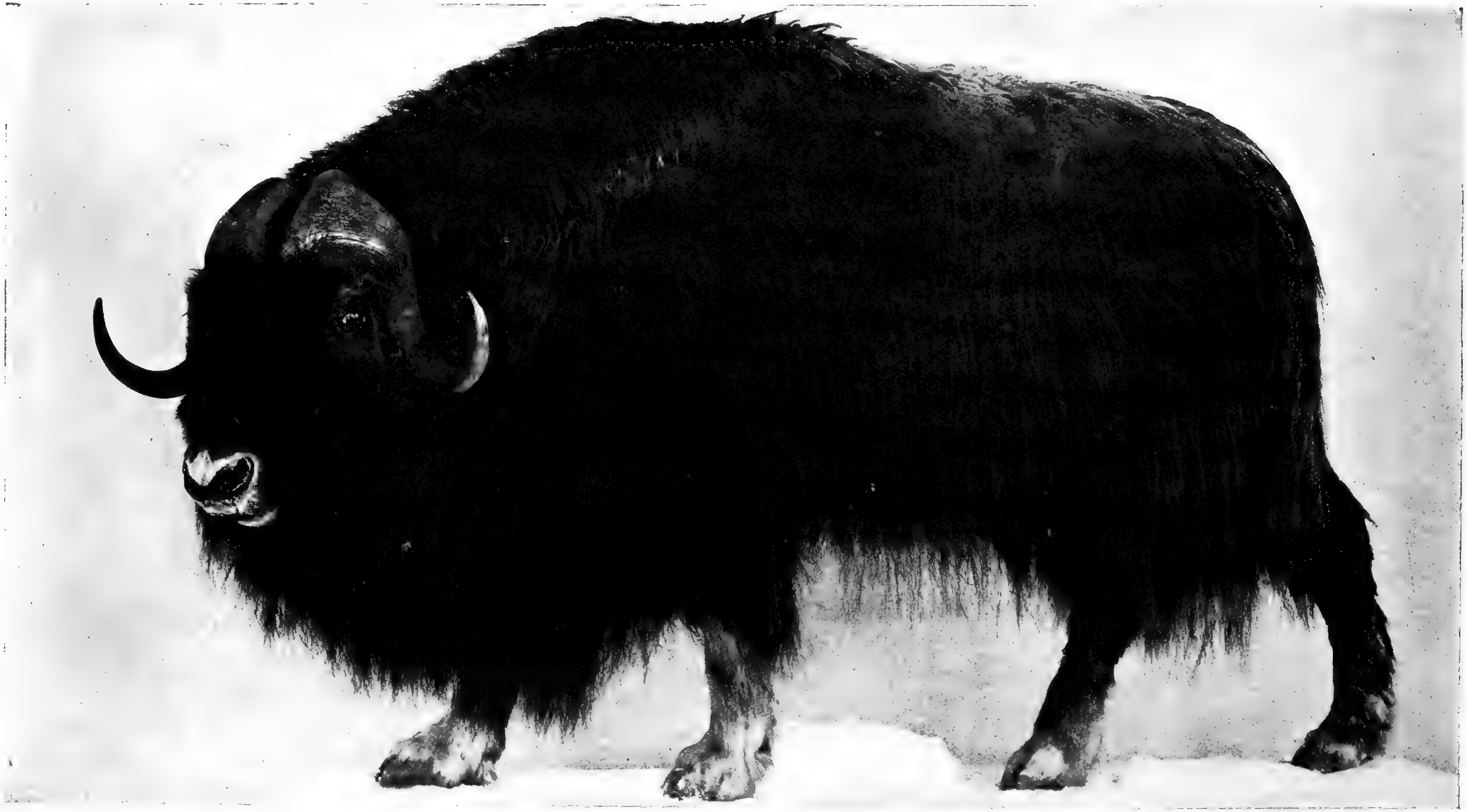
Bighorns, or Mountain Sheep.

The Mountain-Sheep or Bighorns number five species, only one of which is at present well represented in the exhibition collection. This is the Stone Mountain-Sheep from northern British Columbia. Through the Stone Expedition, however, there has just been secured a fine series of the Dall Mountain-Sheep of Alaska, which will furnish material for the illustration of this interesting species by an elaborate group. These two species show the extremes of color in the different kinds of our Bighorns, the Stone Sheep being nearly black and the Dall Sheep, almost pure white. Of the Rocky Mountain Bighorn, the longest known and largest of any of the North American members of the genus *Ovis*, the Museum possesses only a pair of poorly mounted specimens. Efforts have been made and plans elaborated for the construction of a group of this striking species, but the expense of the undertaking has thus far compelled the Museum authorities to postpone any attempt to prepare it.

The southern or Nelson Bighorn, recently described from the Grapevine mountains on the California-Nevada boundary, and the Mexican Bighorn, lately made known from the State of Chihuahua, Mexico, are still desiderata. But the Museum has been fortunate enough to secure specimens of the Fannin Mountain Sheep, discovered the past year near Dawson, Northwest Territory, and known as yet from very few specimens.

Mountain Goats.

The Rocky Mountain Goats comprise two species, one of which has been discovered only recently in the Copper River region of Alaska, and very few specimens of it have as yet reached any museum. The Mountain Goat of the northern United States and British Columbia is represented in our exhibition collection by a single specimen. A group of this species has long been planned, and a few specimens



BARREN GROUND MUSK-OX. ADULT MALE
Mounted specimen in American Museum
(From Bulletin American Museum, Vol. XIV, 1901, pl. xii)

have been gathered for it, but not enough to complete the group The Goats and Sheep are mountain dwellers, and their favorite haunts are the more inaccessible parts of the higher ranges. Yet they have been followed by the hunter into their remotest and most secluded resorts. The Sheep are exceedingly watchful and sagacious, and these traits alone have preserved them from total annihilation. They have been exterminated in the more accessible parts of their ranges, and survive in comparatively small numbers and greatly restricted areas. The Goats were originally much less widely distributed in North America than the Sheep. Their chief protection lies in the inaccessibility of their favorite ranges; since, when once discovered, their safety depends upon the difficulty and danger attending their pursuit rather than upon that keen alertness so characteristic of the Mountain Sheep.

Musk-Oxen.

The Musk-Oxen, or Musk-Sheep, as they sometimes are called, are the only remaining members of the Ruminants to be mentioned. They are, however, neither oxen nor sheep, nor very closely allied to either, but are a very distinct type of the hollow-horned section of the Ruminants, entitled to a distinctive name free from the implication of any such alliance. Like the misapplied name Buffalo for the Bison, however, and of Robin for various birds, in different countries, that are not robins, and scores of other misapplied popular names, the term Musk-Ox has so firm a foothold that it is not likely soon to be displaced. The Musk-Oxen are the most exclusively Arctic of all Ruminants, their home being the remote, treeless Barren Grounds of the far North, where vegetation is scanty, and the ground is buried in snow for a large part of the year. Nature has provided the animal with a heavy fleece of soft hair and wool for its protection against the inclemency of the long Arctic winter. The Musk-Oxen are in the last stages of numerical decline; formerly ranging, in comparatively recent geological times, as far south as Kentucky, Missouri and Utah, and over a large part of Siberia to Germany and England, they now are restricted to the Barren Grounds east of the Mackenzie river, the Arctic islands north of Hudson Bay, and a narrow coast strip on both sides of northern Greenland.

PEARY MUSK-OX. ADULT MALE
Mounted specimen in American Museum. Peary Expedition
(From Bulletin American Museum, Vol. XIV, 1901, pl. xiii)

where their numbers are being rapidly diminished by Indians and Eskimos and by Arctic explorers.

There are two species of Musk-Oxen, the Barren Ground and the Greenland, both of which are well represented in the Museum collection. Six specimens of the Greenland species, secured for the Museum by Lieut. R. E. Peary, have been mounted and installed as a group in Hall No. 207 of the East Wing. The Barren Ground species, also, is well represented by mounted specimens, including the young as well as the adult.

Exhibits Needed.

From the foregoing it is evident that the Museum is very deficient in the large game animals of North America, many of the forms being entirely absent and others very inadequately represented. It is the wish of the Museum authorities to exhibit each prominent species by a group, planned on a large scale, with proper accessories to illustrate the life habits of the animal; in other words, on the same scale as the present Moose and Bison groups in the North American Hall. The careful construction of these groups implies not only a considerable expenditure of money in procuring specimens of the animals for mounting, but also in furnishing the accessories and making the studies for its setting. The designer of a group should visit the country inhabited by the animals it is intended to illustrate, plan the group in the field, and collect samples of rock, soil and vegetation for use in the construction of the exhibit. In no other way can the results be realistic and satisfactory,— exact representations of nature, which it is the purpose of these groups to reproduce. Since not every specimen is suitable for mounting, a considerable series must be collected or purchased in order to select therefrom material that will be satisfactory.

NOTE.—The attention of the reader is called to the fact that in the halls of Ethnology, Nos. 101, 102, 108, on the ground floor of the building, will be found many articles of dress made from the skins of the Deer and other members of the family of Ruminants, also many implements of the chase and of home industries made from the bones and antlers of the Deer, Elk etc. The teeth of some of the Rumi-

PEARY MUSK-OX. ADULT FEMALE
Mounted specimen American Museum. Peary Expedition
(From Bulletin American Museum, Vol. XIV, 1901, pl. xiv)

nants, particularly the so-called "tusks" of the Elk, have been used by the Indians for ornamental purposes. Specimens illustrating such uses will be found in the same halls. The Museum Memoir on the Thompson River Indians, by James Teit, contains descriptions of many such garments and implements, and the specimens therein described are on exhibition in these halls.

The ancestors of the higher Ruminants are mainly of Old-World origin and are comparatively scarce and late in appearance in the fossil beds of our own continent. The following exhibits in the Hall of Fossil Vertebrates, No. 406, on the fourth floor of the Museum, should be examined by the readers of this Guide Leaflet who are interested in evolution:

The Irish Deer, or Irish Elk, (*Megaceros hibernicus* Owen), from near Limerick, Ireland, a form which is related to the recent genus *Dama*. The specimen was presented to the Museum by Prof. Albert S. Bickmore.

A Model, one-fourth natural size, of *Cervalces*, the great Moose-Elk from the Pleistocene beds of New Jersey. The skeleton is in the Princeton museum.

A hind limb of a fossil Bison from the western Pleistocene beds of Nebraska.

The mounted skeleton of *Merycodus* from the Middle Miocene beds of Colorado. This is an extinct type of Antelope, related to the Pronghorn, but possessed of branching, deciduous, bony antlers like those of the deer.

Skulls and other parts of *Palæomeryx* and other Miocene ancestors of the Deer.—EDITOR.

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THE AMERICAN MUSEUM JOURNAL.

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AMERICAN MUSEUM OF NATURAL HISTORY

The Ancient Basket Makers OF Southeastern Utah

BY

George H. Pepper

Assistant, Department of Anthropology

SUPPLEMENT TO AMERICAN MUSEUM JOURNAL

VOL. II, No. 4, APRIL, 1902

Guide Leaflet No. 6

American Museum of Natural History

Seventy-seventh Street and Central Park West, New York City

The American Museum of Natural History was established in 1869 to promote the Natural Sciences and to diffuse a general knowledge of them among the people, and it is in cordial coöperation with all similar institutions throughout the world. The Museum authorities are dependent upon private subscriptions and the dues from members for procuring needed additions to the collections and for carrying on explorations in America and other parts of the world.

The membership fees are,

Annual Members	$ 10	Fellows	$ 500
Life Members	100	Patrons	1000

All money received from membership fees is used for increasing the collections and for developing the educational work of the Museum.

The Museum is open free to the public on every day in the year.

BASKETS AND OTHER OBJECTS FROM THE CAVES OF SOUTHEASTERN UTAH. HYDE EXPEDITION.

The Ancient Basket Makers

OF

Southeastern Utah

A GUIDE LEAFLET DESCRIPTIVE OF AN EXHIBIT

IN THE

AMERICAN MUSEUM OF NATURAL HISTORY

By GEORGE H. PEPPER

NO. 6

OF THE

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EDMUND OTIS HOVEY, EDITOR

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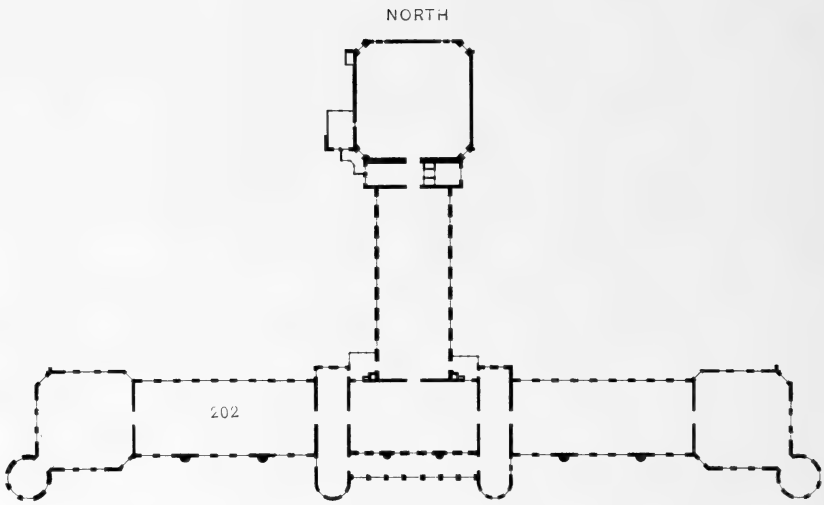


SKETCH PLAN OF SECOND, OR MAIN, FLOOR.

The collection illustrating the ancient basket makers of southeastern Utah is in the southwest corner of Hall No. 202 on the Second, or Main, floor of the West wing of the Museum building.

THE ANCIENT BASKET MAKERS OF SOUTHEASTERN UTAH.

By George H. Pepper,

Assistant in the Department of Anthropology.

The southwestern part of the United States is noted archæologically for its cliff dwellings and pueblos. The cliff-houses are more numerous in Colorado, Utah and Arizona, but the largest group of ruined pueblos is situated in one of the broad cañons of northwestern New Mexico. These homes of the ancient people, though differing greatly in form and situation, as well as the cave lodges and boulder houses of the old river beds, were doubtless the result of environment, and were probably, to a certain extent, occupied contemporaneously. The numerous problems suggested by these ruins have been studied by careful investigators, and exploration work has served to verify many hypothetical conclusions and to disprove as many more; but the work may continue indefinitely, for each season brings to light some new problems of importance, and it is one of these that will be considered in this paper.

The Wetherill family of Mancos, Colorado, have been closely associated with the archæology of the Southwest for nearly a quarter of a century, and they have had the honor of bringing before the public the great Cliff-Dweller region of Colorado and Utah. They have been untiring in their efforts as collectors and are keen observers. Richard, the eldest son, was the leader of most of the exploring trips, and it was he who found, in the Grand Gulch region of southeastern Utah, the skeletons of an ancient people, whose skulls were markedly different from those of the Cliff Dwellers, and who named this new people the "Basket Makers." Two gentlemen, Messrs McLoyd and Graham, followed the pioneers and made a representative collection of the objects and utensils of the Basket people. It is from accounts of the region given by the last named explorers, supplementing the statements of the Wetherill brothers, whom I consider

authorities on this subject, that I shall draw many of my facts.

Richard Wetherill, in writing of this region, says: "Grand Gulch drains nearly all the territory southwest of the Elk mountains, from the McComb Wash to the Clay Hills, about one thousand miles of territory. It is the most tortuous cañon in the whole of the Southwest, making bends from 200 to 600 yards apart, al-

BURIAL CAVE OF BASKET MAKERS, GRAND GULCH, UTAH

most the entire length, or for fifty miles, and each bend means a cave or overhanging cliff; all of those with an exposure to the sun had been occupied either for cliff-houses or as burial places. The cañon is from 300 to 700 feet deep and in many places, toward the lower end, the bends are cut through by Nature, making natural bridges. Under these bridges, in some cases, are houses, and in such places are pictographs in the greatest profusion; the painted ones of the Basket Maker, with the later ones of the Cliff Dweller cut or incised in the rock without paying any attention to previous ones. Ingress and egress are very difficult, there being not more than five or six places where even

The Cañons of Utah.

footmen can get into or out of the cañon. Water is fairly plentiful. Springs occur at very frequent intervals, running a short distance and sinking in the sand perhaps to rise again lower down the cañon. Wherever there are slopes a sparse growth of piñon and cedar occurs; about the springs are cottonwoods, willows and box-elders; in the shaded side cañons are mountain ash and

BASKET BURIAL, GRAND GULCH, UTAH

hackberry. The usual bush of the cañon is scrub oak. Canes or rushes cover the bottom lands in the vicinity of water."

This, then, was the home of the Basket Maker, at any rate, so far as we know. There are evidences that a few, at least, of these people found homes in the caves as far south as the Cañon de Chelle, but nine-tenths of the caves inhabited by these people have been found in the Grand Gulch country.

The Cliff Dwellers practiced artificial flattening of the head. This flattening was confined to the posterior portion of the

skull, and was as pronounced in the women as in the men. The occipital deformity is so noticeable and so constant among this people that a normal cranium among a lot of skulls would attract the attention of an investigator. Mr. Wetherill discovered that two forms of human skulls occurred in the cañons: the broad, short, flattened cranium of the Cliff Dweller and a narrow, elongate, normal cranium. The

Physical Characteristics.

BASKET BURIAL, GRAND GULCH, UTAH

latter was the only kind found buried under baskets, a fact which suggested to the discoverer the name "Basket Makers" as an appropriate appellation for the ancient people whose remains he had found.

But these were not the only marked differences between the two people whose remains are so closely associated. That the Basket Makers used the bow is doubtful. They had, however, a form of weapon unknown in the Southwest, either in ancient or

modern times, save in this restricted area, the throwing-stick, whose nearest neighbor is found in Chihuahua, Mexico, in the form of the "atlatl," an implement of war concerning which wonderful tales were told by the early chroniclers of New Spain. There are other implements and utensils peculiar to this people, one of which is similar to the rabbit-stick used by the Hopi Indians of to-day; but the most striking features are the absence of houses in the caves and the manner of burying the dead.

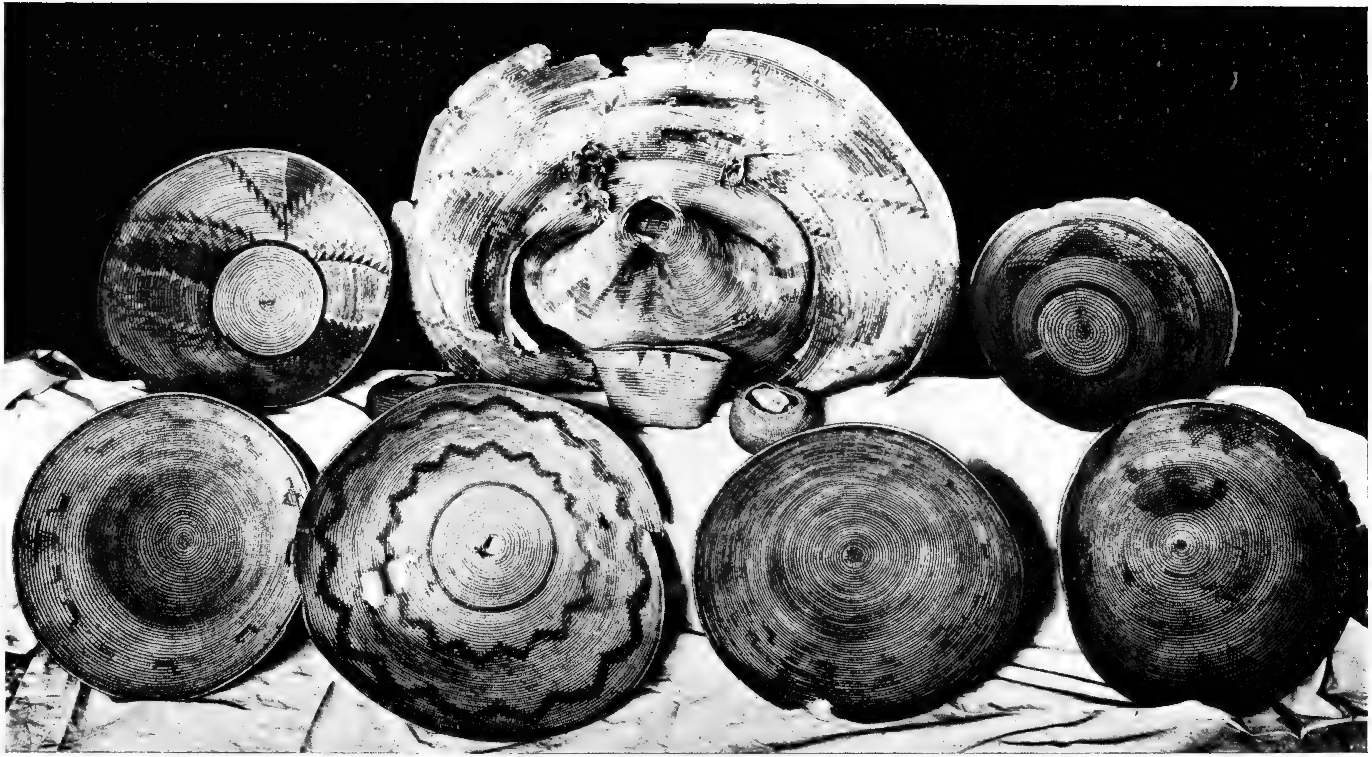
Weapons and Utensils.

The Basket Makers lived in caves, but the investigations in this region furnish no evidences of their having had stone houses. In some of the caves the houses of the Cliff Dwellers have been found over the remains of the earlier Basket Makers. In relation to the rooms excavated by the Basket Makers, McLoyd and Graham say: "Some of the skulls in this collection were obtained from underground rooms that had been excavated in the clay bottoms of the caves. The largest of these rooms are as much as twenty-two feet in diameter. They have been filled in with ashes and other refuse, and the stone cliff houses constructed over them. The heads taken from these rooms are of natural form, never having been changed by pressure. No skulls of this shape are found in the stone cliff houses that are in the same caves, and no flattened skulls are found in the underground rooms. Articles found in the rooms beneath the cliff dwellings are, to some extent, different from those obtained in the stone houses above."

Dwellings.

Wetherill makes mention of a great many depressions in the form of "pot-holes," some of which were lined with baked clay: their use may have been, primarily, the storing of grain or provisions, but a secondary and final utilization was as a grave. In these carefully prepared places, the bodies of the people were buried. They were doubled up and placed at the bottom of the hole, then covered with beautiful feather or rabbit-skin robes and finally with baskets, either several small ones or one large carrying basket. No matter what the character or quality of the other mortuary articles might be, the basket was almost invariably in evidence.

Mode of Burial.



BURDEN AND OTHER TYPES OF BASKETS

The bodies exhibited, commonly known as mummies, testify forcibly to the dryness of the caves in which they were found. They were not subjected to an artificial mummifying process, as many people imagine and as the common name would imply, but were buried in the usual manner, Nature alone being responsible for their present condition. The body instead of decaying, slowly dried. The flesh wasted away, undergoing a gradual process of desiccation, until the skin, flattened on the bones by the pressure of the earth above it, became a parchment-like covering that enclosed the skeleton. This work of Nature was so wonderfully done that the individual external features and peculiarities, although somewhat distorted, are perfectly preserved. The hair, eyebrows and nails are intact, and the ears, the nose, the skin of the face and other fleshy parts of the body are so perfect that they have been rendered almost life-like by a process employed in one of our universities. Nature, in this region at least, has been kind to the archæologist, and, through her carefully prepared store-houses, has made it possible to verify many hypotheses, while at the same time she has preserved for the student many invaluable records of the past.

"Mummies."

THE CULTURE OF THE ANCIENT BASKET MAKERS.

Although most of the ancient Pueblo people and Cliff Dwellers were masters of the art of making pottery it would seem, from the data at hand, that the Basket Makers had not developed whatever ability they may have had in that line. In fact, the majority of the vessels found with the remains of these people are of a very crude type, indicative of the first steps in fictile art as pointed out by specialists. McLoyd and Graham, in speaking of this ware, say: "The third kind of pottery is very valuable, less than fifty pieces having been found up to date, and those in the underground rooms that have been mentioned as being underneath the Cliff dwellings and in the same caves. It is a very crude, unglazed ware, some of the bowls showing the imprint of the baskets in which they were formed."

Pottery.

The pottery mentioned in this statement is on exhibition in

FOOD TRAYS OR MEAL BOWLS

the table case in front of the wall case referred to, and will be described in detail in a future publication.

The large jars on the upper shelf of the wall case containing the baskets are from the caves in which some of the remains of the Basket Makers were found, but they are from the upper levels and are the work of the Cliff Dwellers. Many were used as cooking vessels, but most of the larger ones were receptacles for corn and other provisions. Some of the jars still retain the corn and seeds that were placed there by their original owners, while others are covered with soot that shows the use made of them in the culinary department. It will be noticed that most of the large jars have rounded bottoms, necessitating a stand or base to keep them in an upright position. The stand used was in the form of a ring made either of yucca ("Spanish bayonet") or cedar bark and one of these may be seen attached to the base of a jar. It forms part of a harness made of yucca leaves, which also served to strengthen the jar, and facilitated the carrying of such a vessel. This form of jar is common throughout the greater part of the Pueblo and Cliff Dweller country, and is a good example of the ware in which the coils have not been obliterated by smoothing.

Vessels for Cooking and Storage.

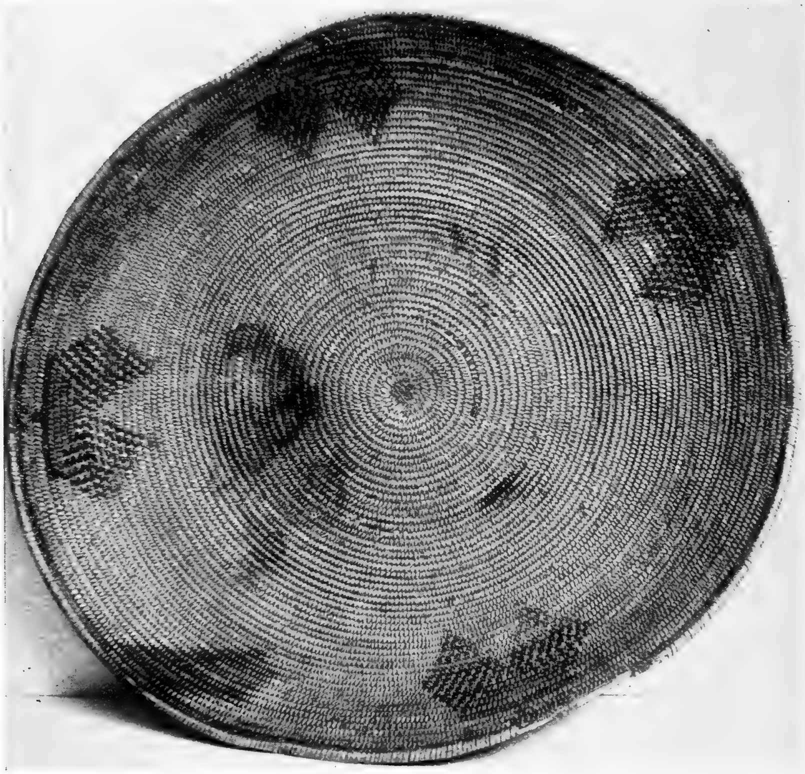
The bottle-necked olla and a bowl are shown as examples of another form. In these the surface has been smoothed and ornamented with painted designs. In the corrugated jars, the designs are generally incised, and are either lines or slight depressions forming figures. In the former styles of decoration a yucca brush is used, while in the latter a bone implement or stick or even the finger nail was enough to give the desired effect.

Other Forms of Jar.

The foot covering of the ancient sedentary people is interesting enough to fill a book with instructive text, but we must merely glance at that here shown and pass on to the great collection of baskets. The yucca plant furnished the material from which these sandals usually were made. Some were plaited from the split leaves of the broad-leaved species, while for others the entire leaf of the narrow-leaved plant was utilized. In making the sandals the progression was from the

Sandals: Material.

toe to the heel. Another form, a thick pad-like sandal, was made from yucca fibre loosely woven, while a fourth was a carefully woven product, both warp and woof being yucca cord. Other materials were employed in the manufacture of these useful articles, and specimens illustrating this fact may be seen in the table case east of the one under consideration.



FOOD TRAY WITH BUTTERFLY DESIGN

Sandals: Shape.

There is a marked difference in shape between the sandal of the Basket Makers and that of the Cliff Dwellers. The latter has a pointed toe, and there is a jog or step a few inches from the toe end. The sandals of the Basket Makers have square toes, apparently without exception. From the crudest form made from broad leaves to the finest woven

product, there is no deviation. The Wetherill brothers made this a point for special investigation, and the square-toed form seemed to persist to the exclusion of the regular cliff-house type. We have McLoyd and Graham's views in the following words: "We are of the opinion that those [sandals] with square

FOOD TRAY WITH WATER-FOWL DESIGN

toes were made by a race who inhabited the underground rooms. This view is formed from finding them buried with mummies of that race and is strengthened by the fact that we have found none in the caves where such ruins do not exist." Thus we may safely assume that this is another characteristic

in which the Basket Makers differ from the Cliff people: at all events, the matter is worthy of further study.

Basketry.

The baskets taken from the various caves of the Grand Gulch region, and shown for the first time in this case, form as complete a collection of pre-historic wickerwork as may be found in this country, and present a new field for the student of ancient weaves. All the large baskets were found with the Basket Makers. The Cliff Dwellers made baskets, and may have learned the art from these people, but most of their productions were small and unornamented. According to McLoyd and Graham: "The large flat baskets or platters have only been found in the underground rooms that have been mentioned." These large dishes or trays are well represented in the Museum exhibit.

The Wetherill Collection.

The northern half of the case is devoted to the material collected by the Wetherill brothers and is the first collection of note that came from the Grand Gulch country. The unique character of many of these baskets would warrant a technical treatment, and the weaves, materials, dyes and designs are all deserving of a more detailed description than this account will permit.

Burden Baskets.

The baskets that claim attention when the case is first approached are the ones that cover the bodies. They are really burden baskets and, though used to cover the bodies after death, were not specifically mortuary baskets. They are from three to four feet in diameter and are conical in form. Some of them still retain their carrying cords and show evidences of long use. As burden baskets they were no doubt used in carrying wood, grain, fruits etc. They are of the coil pattern and have the three-stick core. We find this form of basket in use at the present time among the Apaches, Pah Utes and most of the tribes of northern and central California. In the modern tribes, however, almost all baskets of this shape are of the *bam tush* weave, a weave in which the warp is perpendicular instead of being in the form of a horizontal coil.

The ornamentation here shown is angular and well defined,

and approaches in decorative effect the modern work of the Maidu Indians of California. The material used in the construction of the basket is willow. Splints of this material have been dyed black and a peculiar dull red, and these two colors form the design as shown in the basket on page 8.

Ornamentation.

FOOD TRAY WITH BUTTERFLY AND WATER-FOWL DESIGNS

The conical bottom of this basket has been reinforced and strengthened with heavy yucca cord, because the basket is always put down with this part resting on the ground. This feature may be noticed in the Pah Ute burden baskets of the present day, but the Pah Utes generally bind their baskets with rawhide.

On the first or lower shelf of the Wetherill collection there is a series of eight baskets that were probably used as food trays or meal bowls. Some may have been used as gambling trays with which to toss the bone and wooden dice, while others were, possibly, ceremonial objects that were used only on special occasions. This series is composed of specimens that are practically of the same form. They are made of willow stalks and splints and are of the "three-rod foundation" type, as illustrated and described by Professor Otis T. Mason in the *American Anthropologist*, N. S., vol. 3, No. 1, p. 122. Since almost all of the baskets made by these people are of this type, Mason's description of this particular form of weave as given in the article cited may be quoted here.

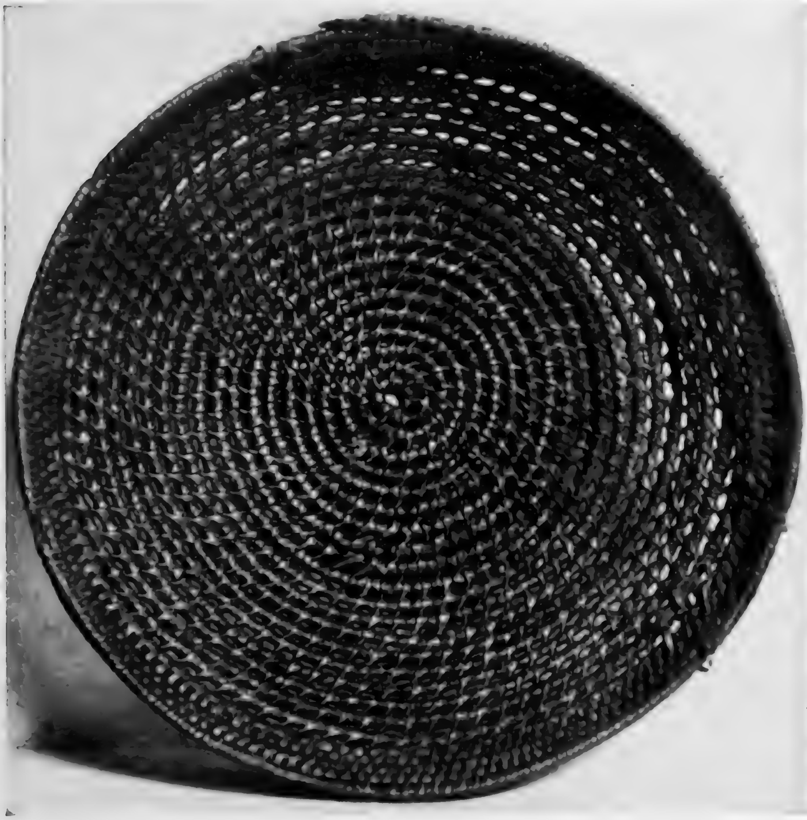
Food Trays or Meal Bowls.

"Three-rod foundation—This is the type of foundation called by Dr. Hudson, *bam tsu wu*. Among the Pomo and other tribes in the western part of the United States the most delicate pieces of basketry are in this style. Dr. Hudson calls them the "jewels of coiled basketry." The surfaces are beautifully corrugated and patterns of the most elaborate character can be wrought on them. The technic is as follows: Three or four small, uniform willow stems serve for the foundation. The sewing, which may be in splints of willow, black or white carex root, or cercis stem, passes around the three stems constituting the coil, under the upper one of the bundle below, the stitches interlocking. In the California area the materials for basketry are of the finest quality. The willow stems and carex roots are susceptible of division into delicate filaments. Sewing done with these is most compact, and when the stitches are pressed closely together the foundation does not appear."

Mode of Manufacture.

Accepting this description as covering the generalities of manufacture, we may proceed to the examination of a few of the individual peculiarities. Beginning with the second specimen from the right of this part of the case we have a basket seventeen inches in diameter, which is slightly concave. The stitch is the ordinary "wrap stitch" with the exception of a space about an inch and one-half from the end of the outer coil, where the

herring-bone stitch was used. This stitch is employed by the modern Pah Utes, Navajos, Supais and Pimas, but with these tribes the entire rim is finished in this manner. The design on this basket, as shown on page 12, is a very unusual one. Mr. T.



OPEN-WORK, OR "SIFTER" BASKET

Butterfly Designs.

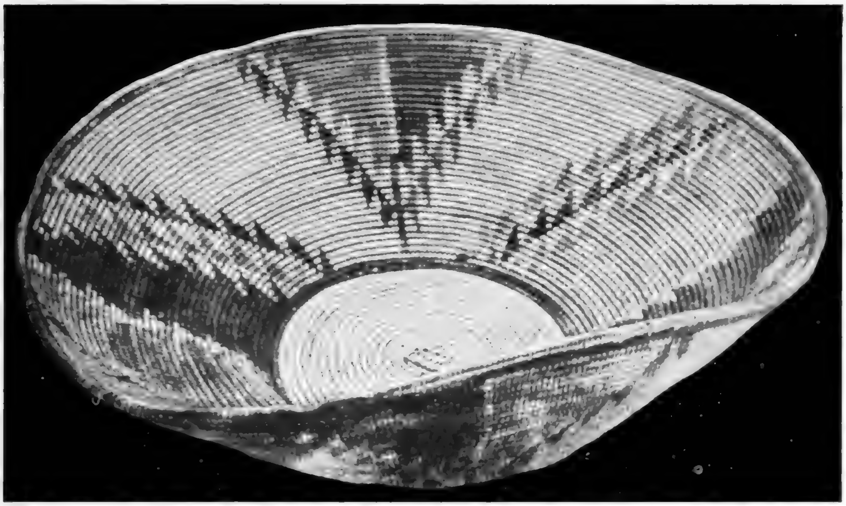
F. Barnes of Los Angeles, California, has suggested that it may be a conventionalized representation of butterflies and that the basket was probably a ceremonial one, used when a child was born, the butterfly being symbolical of the new life. In verification of this supposition, the entry in Wetherill's original catalogue shows that this basket was found over the "partially mummified remains of a child." The design is in two

colors. The space below the bar and between the wings is a dull red-brown, the remainder of the figure being black. These designs are not equidistant as is generally the case in ancient decorative work of this region, and the position of one of the figures directly below the finished end of the outer coil may point to a symbolic relation between the design and the closed or finished coil.

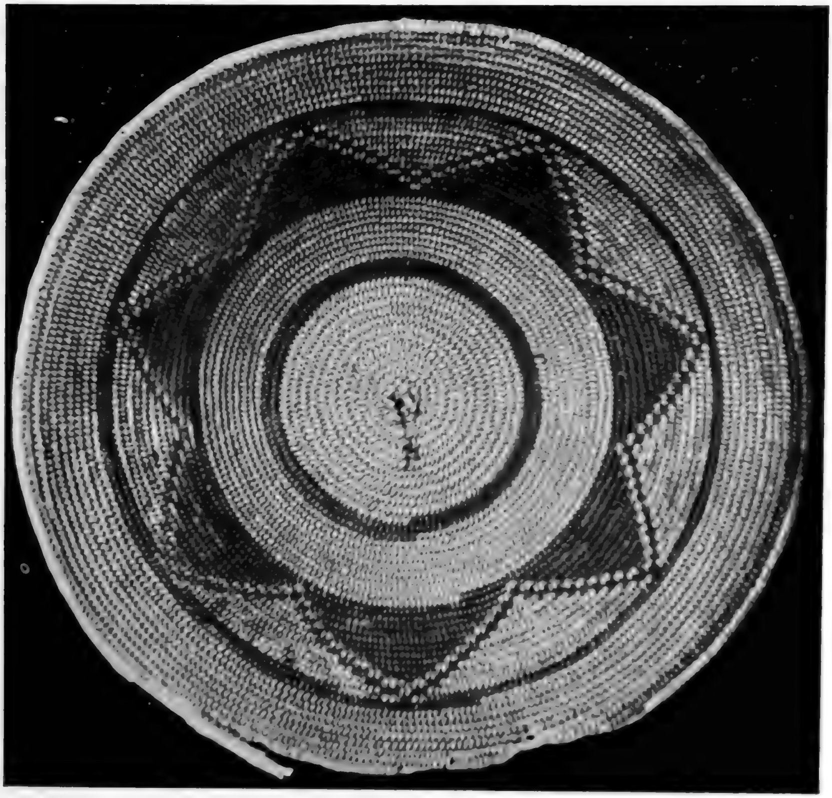
Water-fowl Design.

Another decoration, as interesting as it is odd, is shown in the fourth basket from the same end of the case. This basket was found in a cave and may be seen in position in the plate on page 5. In this instance the basket covered the head and upper part of the body, the remainder being wrapped in a feather-cloth robe. The figures shown in this basket, forty-four in number, were evidently made to represent ducks or other water-fowl, and they form two lines or series (p. 13). All the figures pointing in one direction are black; those facing them are dull red, and are raised slightly above the others in a horizontal plane. A line of black near the rim constitutes the remaining feature of the decoration of this basket. In size and material it is practically the same as the one just described and the design is similar, in some respects, to the fifth basket, which is also decorated with the bird figure. In the photograph of this basket shown on page 15 it will be seen that the designs in the two baskets that have been described last are combined in this one. The bird-forms are practically the same, but the body of the butterfly, if it be one, is represented by one instead of three parts. In the former the figure may have been made to represent the butterfly just after its emergence from the chrysalis, with the wings extended, which would have been a pretty symbolization of the new life as applied to the infant, while in the latter the wings are folded, and the butterflies, like the birds, are resting. The designs, however, may have a cosmic significance, the figures typifying the gods of the air and the water. An interesting feature of these figures is the antenna-like projection that may be noted on both baskets. There is a black coil near the rim of the basket; where this ends there are two black stitches on

Other Designs.



BOWL-SHAPED BASKET WITH SUN-AND-MOUNTAIN DESIGN



BOWL-SHAPED BASKET WITH MOUNTAIN DESIGN

the outer coil. From this point to the end of the coil is a little more than an inch, and the finishing half of this portion is done in the "herring-bone stitch."

Sifter Baskets.

Inasmuch as all the other baskets on the shelves are of the same form and general workmanship as those already described, we will pass on to those on the floor of the case. Here we find a type, shown on page 17, which is unusually interesting. It is a sifter basket of the single-stick variety and the weave is very peculiar. The basket is nine and one-half inches in diameter and two inches deep. The fact that it is a coiled basket makes it doubly worthy of notice. Sifter baskets are found among the Apaches, Pimas, Pah Utes and Pomas of the present day, which are, however, of the *bam tush* weave. Open-stitch work is seen to-day among the Klikatats of Washington and in the Attu baskets of the Aleutian islands. This basket is made of willow and is well preserved. It is not decorated, but the stitch is a peculiar one and therefore lends a charm that claims our attention. An examination of the specimen, or even of the photograph, will serve to give a better idea of the structure than could be gathered from a description.

While considering the large baskets it may be well to examine those collected by McLoyd and Graham and then return to the smaller specimens in the Wetherill collection.

The McLoyd and Graham Collection.

The McLoyd and Graham collection occupies the southern half of the large case. The first specimen to be considered is the second one from the right on the first, or bottom, shelf, and it is probably the most beautiful example of pre-Columbian basketwork in existence. The basket is of the three-stick weave, with flat bottom and flaring sides, and is seventeen and one-half inches in diameter and five inches in depth. The highly ornamental geometrical design, in black and dull reddish brown, is illustrated on page 19. This basket, like many others, was found buried with the body of a child which had been wrapped in fur-cloth and deerskins. From the æsthetic standpoint, this basket is a treasure, and its utilitarian value must have been

as great as its ornamentation is beautiful. The split willows forming the design were dyed a glossy black and a dull reddish brown, the pattern formed of the latter color giving the effect of an under-tint. The design is bold and somewhat startling

FOOD OR GAMBLING TRAY

and is confined to the flaring part. The flat bottom presents the appearance of a disc from which wings extend; the designs forming these appendages start from the opposite sides of its circumference, which is defined by two black lines. These wing-like figures are broad and have serrated edges. They extend to a black line that forms the second coil

Winged Design. (?)

of the rim. On one side of each wing there are two well defined lines that have the appearance of wave-lines. On the other side there is a design in the dull red color that seems almost like a shadow. This too is flanked by two lines similar to the ones just mentioned. There are two designs similar to those employed by the Pomas of the present day. They are in the form of mountains and occupy positions on opposite sides of the basket. The base of these figures rests against the black line

Sun-and-Mountain Design. (?)

that skirts the rim and the terraced tops almost reach the rim of the central part. The most forcible impression of this ornamentation in its entirety is that of the winged sun soaring over the earth as represented by the mountains. Neither a photograph nor a description can do justice to this wonderful evidence of the work that could be done by the old people; the specimen itself must be examined if one would fully appreciate the capabilities of the ancient Basket Makers.

Another basket of beautiful design and workmanship is figured on page 19 and may be seen on the first shelf of the

Mountain Design. (?)

case. It is similar to the one just described both in shape and weave. Its special claim upon our attention is its decoration. This is in the form of heavy mountain-like figures that form a band midway of the rim. There are the same lines of black separating the bottom and upper part as seen in the other baskets, then there is a plain space before the terraces begin. There are seven of these pyramidal figures and their bases are joined, forming a rosette. The tops of the figures are toward the rim and rest against a black coil. A single black coil near the rim completes the ornamentation. This basket and the one with the wing design are the only ones in our collections with heavy designs, the tendency being toward a more delicate treatment.

A third specimen of the flat-bottomed form is shown on page 21. It has the double coil of black that forms the limit of the bottom piece and from this the sides extend, their edges being twenty inches apart. The design is in black and is formed by two zig-zag bands, one of which is near the rim and the other

near the bottom. This basket was found with a mummy and with it were three others. It has weathered more than the

YUCCA SPLINT BASKET FOOD BASKET OF COILED WORK

SMALL STORAGE BASKETS

other baskets, but it is one of the largest, and the design is a very striking one. There is a gambling tray from the Tule River reservation, California, in the Briggs collection in the

American Museum, that has a design similar to this one, and the weave of the basket is practically the same.

Turning to the coarser weaves we have on page 23 two baskets that show conclusively that they were made for every-day use.

Coarsely Woven Baskets.

One is a bowl-shaped piece eleven inches in diameter and four and one-half inches deep; it is of the usual coil pattern, but coarsely woven as compared with those already noted. This basket was used until the bottom gave out and even then it was not discarded. It was mended with strong strips of split willow and each strip included two coils. The basket was strengthened to such an extent by this reinforcement that it was really as good as new. The second basket shown on this page is made of yucca leaves. It is fourteen inches in diameter and four inches deep. This form and weave are common among most of the modern Pueblo tribes and even the finish is the same. It is also found among the Apaches and Pimas. The rim is a willow stick over which the yucca ends have been bound and tied, the tying being done on the outside. A number of smaller baskets of this type are shown in the case and one of them is figured on page 23 among the baskets shown with their original contents.

The basket last mentioned is exactly like the large yucca one, except in size, and in the plate cited we may see it as it was

Storage Baskets.

found. It is filled with beans, which must have been raised in quantities by the ancient people, since a great many have been found in the debris of the rooms.

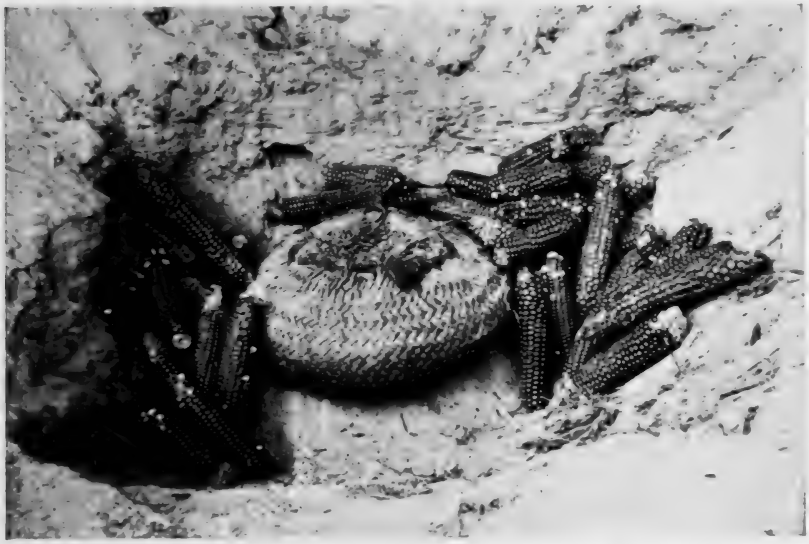
The basket shown above the one just mentioned is rather peculiar in form, since the bottom is oval, a rather unusual shape

Oval Baskets.

in pre-historic baskets. Most of the baskets from the caves are round, but several of the oval form have been found; enough, in fact, to show that the shape is not a freak. This specimen is eight inches long, three and one-half inches wide at the top, two inches wide at the bottom, and four and three-quarter inches long. Its depth is four inches. This basket is of the three-stick weave, and the materials used are the same as in the others. The bottom is flat and there are two coils of black separating the top and bottom. There are two pointed

designs in black near the rim on either side. When found, these baskets were filled with popped corn, piñon nuts and seeds.

In the lower right-hand corner of the same photograph there is represented a small basket containing feathers which were kept in place by means of a piece of cotton cloth completely filling the upper part of the basket.



YUCCA BASKET AS FOUND IN A CAVE, GRAND GULCH UTAH

The remaining three baskets represented on page 23 are of the "in-curve" form. Two have flat bottoms, but the third is like an olla in shape. They have the three-stick core, and the weaving of the two shown in the left part of the picture is the same as that already described. The third, in the upper right-hand corner, has what is known as the "skip stitch," which may be seen in some of the old Pima baskets. The ordinary in-curve basket is found among the modern Pomos of California, but is extremely rare among ancient peoples. These baskets, although not as pretentious as the larger ones, present a phase of the domestic life that appeals to the student, because they are the receptacles for holding the little things that are so common and yet so essential in the every-day life.

"In-curve" Baskets.

Some were storage baskets in which seeds were kept, perhaps for the next season's planting. One of them contains piñon gum, which was their paste and glue. With this gum they mended their broken vessels and made their baskets water-tight, as may be seen by the olla-bottomed basket represented in the plate. This little water bottle is filled with pumpkin seeds and the covering of gum has rendered it water-tight.

Another form of basket that may be considered under this class is shown on page 25. It is more like a yucca bag than a basket, and yet it is made in the same way as are the other yucca productions. It is really a small storage basket and it is here shown filled with shelled corn while about it are scattered ears of corn. This basket and corn were found in a pot-hole in a cave and were no doubt cached in this place for future use. Near the basket just described and leaning against the back of the case is a specimen that is evidently a mortar basket. It is thirteen inches in diameter and three and one-half inches deep. The interior is coated with meal and the surface of the coils is worn as though from blows of a pestle or grinder. The home of the mortar basket is in California and, should future investigations show that this form of basket was used by the ancient people of Utah, it will mark the eastern limit of the type, so far as known.

Mortar Basket.

Much more might be said concerning these interesting objects. Those that have been noted are worthy of a detailed description and there are more than fifty others in this case that must be passed without even mention. The collection as a unit may be studied with the help of this introduction, which will prepare the student for more specific information regarding the arts of the Basket Makers.

NOTE.—The various types of baskets mentioned in this description of the remains of the pre-historic inhabitants of south-eastern Utah are also to be seen in the basketry of the Indian tribes now inhabiting California and other parts of the western United States, examples of which are on exhibition in the West hall, ground floor; and in that of the natives of British Columbia, Alaska and the Aleutian islands, as exhibited in the North hall, ground floor. Inasmuch as the same design expresses different ideas when used by different tribes, it is well for the reader to bear in mind the point made clear in the text by the author of this Leaflet, that the interpretation offered here for the designs on the pre-historic baskets is wholly conjectural.—EDITOR.

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(*Continued on page 3 of cover.*)

AMERICAN MUSEUM OF NATURAL HISTORY

The Butterflies of the Vicinity of New York City

BY

William Beutenmüller

Curator, Department of Entomology

SUPPLEMENT TO AMERICAN MUSEUM JOURNAL

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THE BUTTERFLIES OF THE VICINITY OF NEW YORK CITY.

By William Beutenmüller,

Curator, Department of Entomology.

Butterflies and moths belong to the order of scaly-winged insects or "Lepidoptera." The two may be distinguished readily by the fact that the butterflies have the tips of the antennæ thickened into knobs, while the antennæ of the moths are thread-, comb-, or feather-like. Butterflies fly in the sunshine, but moths generally are night fliers.

The eggs of butterflies are far more variable in shape than are those of moths and insects of other orders, and their surface often is elaborately ornamented with raised lines and spots. They are laid singly or in masses. The caterpillars are long and cylindrical, and are composed of twelve joints or segments besides the head. Each of the first three segments bears a pair of simple, short, articulated feet. These three segments represent the thorax, and the remaining nine the abdomen, of the perfect insect. The sixth to the ninth and the last joints of the caterpillar as a rule are furnished with a pair each of thick, fleshy limbs, termed "pro-legs." These legs have powerful muscles and are provided at their extremities with a great number of minute recurved hooks which enable the caterpillar to hold to its place of rest. When fully grown, they suspend themselves from some convenient object by means of a silken button, some using a silken thread around the body in addition to the button, and change into chrysalids.

The present Guide Leaflet[1] is a popular account of the butterflies which are to be found within approximately fifty

[1] Those who are interested in pursuing the study of these butterflies further, are referred to the author's "Butterflies Found within Fifty Miles of New York," Bulletin American Museum of Natural History, Vol. V, pp. 241–310, 1893.

miles of New York City and is intended to be used not only in connection with the Local Collection on exhibition in the Museum, but also as a concise handbook for the purpose of identifying the species in the field. The butterflies found in the vicinity of this city are representative of four families, the Papilionidæ, the Nymphalidæ, the Lycænidæ and the Hesperidæ, and will be described in that order. The figures used in illustrating the species are all natural size, and most of them show the under as well as the upper side of the wings. Some of the figures illustrate also the wings of the female. The collection has been installed in the flat cases on the railing of the gallery in the Central hall of the third floor.

Family PAPILIONIDÆ.

The butterflies of this family found in the vicinity of New York are divided into two subfamilies: viz., Papilioninæ and Pierinæ.

Subfamily Papilioninæ.

These are large butterflies, commonly known as Swallowtails, because of the tail-like appendages on the hind wings. In the tropics some species occur without these tails. The antennæ are slender, the knob at the tip either straight or curved. The body is provided with six feet fitted for walking. The caterpillars are usually smooth or are provided with fleshy protuberances, and in the upper part of the first segment is a forked scent-organ which may be thrust out or drawn in at will. This organ gives off a disagreeable odor when extended, which serves as a protection to the caterpillar. The chrysalids are attached by the tail to a button of silk, and the body is suspended obliquely in a loop of silk that passes around it a little in front of the middle. The species of *Papilio* may be separated readily by the following synoptic table:

Synopsis of the Papilioninæ.

With very long tails.
  Pale green, with black borders and stripes.........*Papilio ajax.*
With short tails.
  Ground color black.
    With bluish or greenish reflection.............*P. philenor.*
    With bands composed of yellow spots..........*P. asterias.*
    With hind wings very thickly clouded with green scales (male) or blue scales (female)........*P. troilus.*
    With yellowish spots and broad band at base of hind wings.........................*P. cresphontes.*
  Ground color yellow,
    With black bands and stripes...................*P. turnus.*
  Ground color sooty brown,
    With black bands and stripes.......*P. turnus*, var. *glaucus.*

1. **Tiger Swallowtail** (*Papilio turnus*).

This butterfly inhabits all sections of the United States and Canada from the Atlantic coast to the Rocky mountains. In the vicinity of New York it is common and double-brooded, the first brood appearing in the latter part of May and June, and the second in July and August. The butterfly is yellow with transverse black bands.

An aberration occurs in the female which is sooty brown, instead of yellow, with the black markings faintly visible (var. *glaucus*). The female lays her eggs singly on the upper surface of a leaf, and the young caterpillar takes up its abode on the same side, reposing on a bed of silk, which it spins for the purpose of retaining its hold on the smooth surface of the leaf. When disposed, it goes to the edge of the leaf to feed. As the caterpillar increases in size, the leaf is somewhat drawn together, making the animal difficult to discover. It is green, and has on each side of the third segment an irregular oval, greenish-yellow patch edged with black and enclosing a purple spot. At the junctions of the fifth and sixth segments is a transverse, narrow, yellow and black band. It feeds on apple, quince, plum, thorn, cherry, birch, basswood, ash, alder, willow, oak, tulip-tree etc.

In the Hall of North American Forestry there is a group showing a branch of the tulip-tree bearing male and female butterflies, the caterpillar and the chrysalid of this species, and illustrating the effect the insect has upon the leaves of the tree.

2. **Black Swallowtail** (*Papilio asterias*).

Very common in open fields, especially where the wild parsnip grows, from May to October, but it is most common in August.

The butterfly is black, with two rows composed of yellow spots on each wing. The hind wings have blue scales or dashes between the two rows of spots. In the female the yellow spots are much smaller, and the blue scales very prominent. The caterpillar is bright pea-green, with a transverse black band on each segment, containing a row of yellow spots. It feeds on parsley, parsnip, celery, carrot and other allied plants. The species is found in Canada and the United States from the Atlantic to the Pacific coasts, in Mexico, Central America and the Antilles.

3. **Green Clouded Swallowtail** (*Papilio troilus*).

Found in open, sunny spots and along wood paths from the latter part of May until late in June, and again in August. The butterfly is velvety black, with a row of pale yellowish spots near the outer border on the fore wings. The hind wings are densely clouded with green scales in the male, with blue in the female. It is a common species, being distributed over a large area in America north of Mexico. The caterpillar lives on sassafras and spice-bush. It is green, with two very conspicuous eye-like spots on the third segment. It spins a silken web on the leaf on which it abides, drawing the leaf together lengthwise

4. Giant Swallowtail (*Papilio cresphontes*).

This handsome Swallowtail Butterfly is one of the commonest insects in the South, and is seen everywhere flitting about in the orange groves. When first discovered, it was thought to be restricted to the South, but within the last twenty years the butterfly has extended its range very much, being now found as far north as Canada. In the vicinity of New York it is not common. It is double-brooded; the first brood appearing in June and the second in August. It may be known by its large size and its deep black wings, with a row of large, rounded, yellow spots running obliquely from the apex to near the base. From about the middle of this row begins a row of spots which runs to the hind angle. The hind wings have a rather broad band across the base, and a series of large yellow spots running from the apex to the inner angle. The under side is almost entirely yellow. The caterpillar is dark brown with a white band on each side,

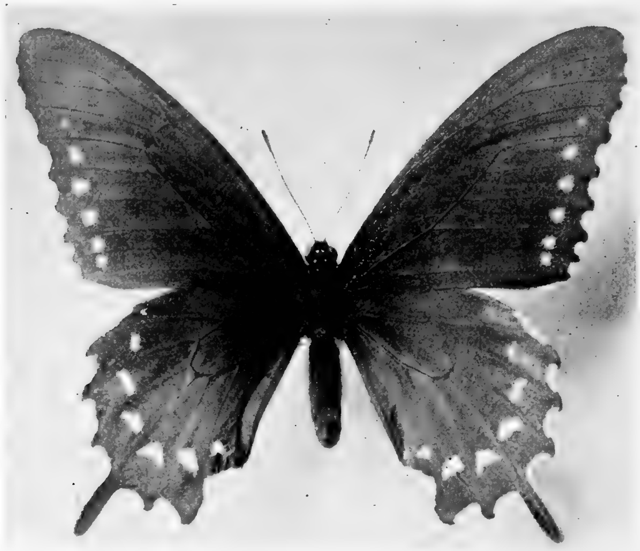
extending from the head to a large whitish patch, mottled with olive and brown. At the end of the body is also a whitish patch. A number of rings are scattered over the body, especially on the anterior parts.

In Florida, the insect is a pest to the orange, and, on account of the large size and voracity of the caterpillar, it is commonly known as the "Orange Dog." It does considerable damage, especially to young trees, which are often completely defoliated. In the North it feeds on the hop-tree (*Ptelea trifoliata*). The female butterfly deposits about five hundred eggs; she scatters them over a wide area, seldom laying more than four or five upon a single plant.

The effect of this insect upon the hop-tree is illustrated by a group in the Hall of North American Forestry consisting of a branch of the tree with male and female butterflies, the caterpillar and the chrysalid.

5. Zebra Swallowtail (*Papilio ajax*).

A pale green species with black borders and transverse stripes; hind wings with a red spot at the anal angle, and with very long tails. Only a few specimens have been seen flying or have been taken in this vicinity. It is common in the Southern and Western States. The caterpillar lives on papaw.



6. Blue Swallowtail (*Papilio philenor*).

Common in this neighborhood, but rather local, owing to the scarcity of the food-plant, snake-root (*Aristolochia serpentaria*). It may be found in May and June, and again in August and September, in open woods, and in gardens, where the caterpillar feeds on the cultivated Dutchman's-pipe (*Aristolochia sipho*). The butterfly may be known easily by the velvety black wings with greenish or bluish metallic reflections, and the row of large orange spots on the hind wings below. The caterpillar is velvety black with long black and orange fleshy tubercles and orange spots. It is found throughout the United States and Canada, and in Mexico.

Subfamily PIERINÆ.

The species belonging to this subfamily are usually of medium size, nearly always white, orange or yellow. They have no tail-like appendages on the hind wings. The inner border of the hind wings is bent downward, forming a channel in which the abdomen rests. They are pretty and graceful, with a tolerably swift, irregular flight. They are known as white, yellow, sulphur or orange butterflies. The caterpillars are

cylindrical, usually with very fine short hairs. They also lack the scent-organ of the Papilios. They live almost exclusively on plants belonging to the pulse family (Leguminosæ) and the mustard family (Cruciferæ). The chrysalids may be distinguished at once by the presence of a single pointed projection in front, and sometimes they are very much enlarged ventrally, so as to be almost triangular in shape. The eggs are much longer than broad, taller than those of any other group of butterflies; they are vertically ribbed, and almost invariably laid singly, though sometimes in open clusters.

Synopsis of the Pierinæ.

Pieris.

White, with black spot on fore wings (two in the female). . . . *P. rapæ.*
Pure white, without markings. . . . . *P. oleracea.*
With veins on under side of hind wings heavily bordered with
greenish scales. . . . . *P. protodice.*

Euchloë.

Upper wings falcate, tipped with orange in the male. . . . . . . *E. genutia.*

Catopsilia.

Wings bright lemon-yellow. . . . . *C. eubule.*

Colias.

With silvery spot in middle of hind wings beneath.
Wings sulphur-yellow, with black borders. . . . . *C. philodice.*
Wings orange, with black borders. . . . . *C. eurytheme.*
Fore wings with a yellow "dog's-head" patch. . . . . . *C. cæsonia.*

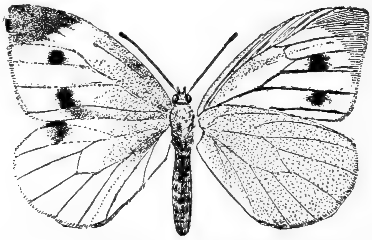
Eurema.

With no silvery spot in middle of hind wings beneath.
Wings bright orange, with black borders. . . . . *E. nicippi.*
Wings lemon-yellow, borders black, with ferruginous spot
on apex of hind wing beneath. *E. lisa.*

7. White Cabbage Butterfly (*Pieris oleracea*).

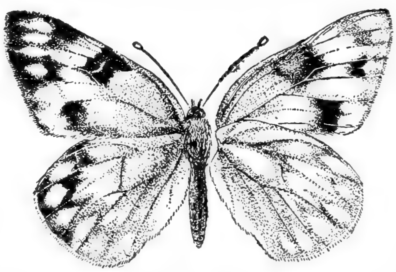
This butterfly may be known from its congeners through its having the upper side of the wings entirely white. It is three-brooded, the first brood appearing from the latter part of April until about

the middle of May, the second late in June until early in July, and the third from late in July until early in September. The spring brood has the under surface of the hind wings and tips of the fore wings heavily washed with yellow, while the summer broods are entirely pure white. The caterpillar is pale green, covered with fine, short, white hairs, and has a dark green line along the back. It feeds on various kinds of cruciferous plants such as cabbage, turnip, radish, mustard and horseradish.



8. Imported Cabbage Butterfly (*Pieris rapæ*).

This species is an importation from Europe, and is exceedingly common from May until November. It may be seen everywhere, in gardens, pastures and other places, but especially in cabbage fields. It was first noticed on this continent in Quebec, Canada, about 1860, whence it gradually extended its range. In 1868 it was independently introduced at New York. Since then the butterflies have spread from Canada to Florida and westward to the Pacific coast. The caterpillar lives on all kinds of cruciferous plants, such as cabbage, to which it is particularly injurious, cauliflower, turnip and radish.



9. Southern Cabbage Butterfly (*Pieris protodice*).

This butterfly is white with black dashes and spots. There are two broods each year, the first coming out in May and June and the second from about July to October. The caterpillar lives on

cabbage and allied plants. The species is found in the United States from ocean to ocean, and also in Mexico. It was common about New York in former years, but since the introduction of the Imported Cabbage Butterfly it has disappeared almost entirely, though it is sometimes common for only a season or two in certain localities.

10. **Dog's-Head Butterfly** (*Colias cæsonia*).

This southern species is occasionally taken in this vicinity. In the South it is common. It may be known readily by the yellow dog's-head patch on the fore wings, and broad black borders.

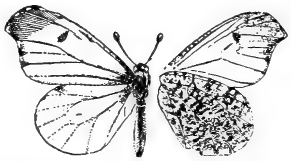
11. **Clouded Sulphur Butterfly** (*Colias philodice*).

Very common everywhere in this neighborhood, along roadsides, in open fields and in gardens. It is especially common when the red clover is in blossom. Sometimes hundreds of these yellow butterflies may be seen in dense masses upon wet spots in the road, swarming when disturbed and settling again when the interruption ceases. It is apparently triple-brooded, and may be found on the wing from the latter part of April until about the middle of October. The

butterfly is readily known by its sulphur-yellow wings with black borders. A pale form of the female occurs in which the wings are whitish or yellowish-white; sometimes a male form occurs which is thickly covered with black scales, so as to obscure the yellow ground color. The caterpillar lives on clover and allied plants.

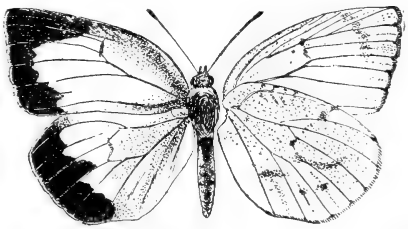
12. **Orange Sulphur Butterfly** (*Colias eurytheme*).

Very rare in this vicinity, but common in the Southern and Western States. It differs from *Colias philodice* in having the wings orange instead of yellow. The caterpillar lives on clover.



13. **Orange-Tip** (*Euchloë genutia*).

This pretty species is local, and appears to be restricted to certain localities. It is on the wing early in May, and flies until about the middle of that month. The butterfly is white with the tips of the fore wings orange in the male; the under side of the hind wings is marbled with green. The caterpillar is dark yellowish-green, glossy, with a yellow stripe along the back and a broader white one on each side. It feeds on rock cress (*Arabis*).



14. **Orange Butterfly** (*Eurema nicippi*).

About 1880 this beautiful species appeared in considerable numbers in Central Park, New York City, and other places around New York, but since then only a few specimens have been taken. The butterfly is found from the Atlantic to the Pacific, and in most of the States south of Lat. 40° in Mexico and in Central America. In the South it is very abundunt. The caterpillar lives on senna (*Cassia*).

15. Little Sulphur Butterfly (*Eurema lisa*).

A small yellow species with black borders. Rather common in sandy places in June and again in the latter part of August and early in September. The caterpillar is grass-green, with minute hairs and white elevation; feeds on clover and senna (*Cassia*).

16. Cloudless Sulphur Butterfly (*Catopsilia eubule*).

This species may be recognized by its large size and sulphur-yellow wings. The caterpillar feeds on different species of senna (*Cassia*). It is a common species in the South, but is rarely met with in the vicinity of New York, a few specimens having been taken in recent years in September and October. In 1870 it was found in abundance on Fire Island, L. I., and numbers were also seen at Long Branch some years ago. It has also been taken in different places on Long Island, Staten Island, Manhattan Island, Westchester County and New Jersey. It is found from New England and Wisconsin to Patagonia, S. A.

Family NYMPHALIDÆ.

The members of the family found in this vicinity are divided

into the following subfamilies: Euploëinæ, Nymphalinæ, Satyrinæ and Libythenæ.

Subfamily Euploëinæ.

This subfamily is almost entirely confined to the equatorial regions of America and Asia. The butterflies average far above medium size, and have rounded, somewhat elongate wings. Their flight is powerful and sustained, although usually slow. They often sail high in the air on expanded wings. The eggs are slender obconic, vertically ribbed and transversely striate, and are laid singly on the food-plant. The caterpillars have two or more segments each with a pair of long, slender, flexible filaments above. The chrysalids are always suspended from a silken button at the hinder part. Only a single species of this family is found in this vicinity—the Milkweed Butterfly.

17. Milkweed or Monarch Butterfly (*Anosia plexippus*).

Very common in this vicinity, appearing in May and June, but becoming more numerous in August and September. In years when conditions have been favorable to the insects' increase, immense swarms of the butterfly may often be seen in autumn migrating southward. It inhabits North America, South America, West Indies, Sandwich Islands, Australia, New Zealand and the Malay Archipelago. The caterpillar lives on milkweed, and the chrysalid is pale green with golden markings.

Subfamily NYMPHALINÆ.

This is the most extensive subfamily of butterflies and embraces an almost infinite variety of forms in every stage of its existence. The flight of the butterflies is usually strong. They generally pass the winter as a butterfly or a caterpillar, and in no instance does the egg hibernate.

Our species may be separated by the following table:

Synopsis of the Nymphalinæ.

Argynnis.

Orange-brown with black markings; hind wings with silver spots beneath.
  Large species.
    Upper side of hind wings black, with a bluish reflection and two rows of spots . . . . *A. idalia.*
    Under side of hind wings with a broad yellowish band . . . . *A. cybele.*
    Under side of hind wings with a narrow yellowish band . . . . *A. aphrodite.*
  Small species.
    With silver spots on under side of hind wings . . . . *A. myrina.*
    Rusty brown on under side of hind wings and without silver spots . . . . *A. bellona.*

Euptoieta.

Upper side fulvous, with black markings; under side of hind wings with brown and ashen-gray shades . . . . *E. claudia.*

Melitæa.

Black, with rows of pale yellow spots, and a row of brick-red spots along the outer borders . . . . *M. phaëton*
Brown and black, similar to *P. nycteis.*
  Under side of hind wings checkered . . . . *M. harrisii.*

Phyciodes.

Upper surface fulvous, with black markings.
  Under side of hind wings with silvery white bands . . . . *P. nycteis.*

Under side of hind wings with grayish, brown and ochraceous blotches (form *marcia*), or entirely ochraceous with a brown outer patch (form *morpheus*), and with transverse brown lines . . . . *P. tharos.*

Polygonia.

Wings falcate ; brown with black markings.
- Under side of hind wings with a broken C . . . . . *P. interrogationis.*
- Under side of hind wings with C not broken. . . . . *P. comma.*
- Under side streaked with black lines . . . . *P. progne.*
- Under side marked with olive-green on the outer parts . . *P. faunus.*
- Hind wings above with a large white spot on the costa . . *P. j-album.*

Vanessa.

Wings velvety brown, with yellow borders . . . . *V. antiopa.*
Smaller in size, with a broad fulvous transverse band on each wing . . . . *V. milberti.*

Pyrameis.

Wings velvety brown, with an oblique red band . . . . *P. atalanta.*
Wings fulvous with black markings.
- With two large eye-like spots on under side of hind wings . . . . *P. huntera.*
- With five small eye-like spots on under side of hind wings . . . . *P. cardui.*

Junonia.

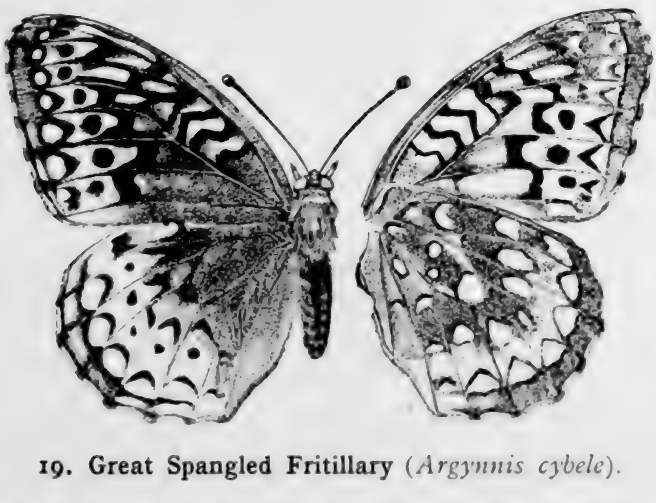
Wings sepia-brown, with large eye-like spots above . . . . *J. cœnia.*

Limenitis.

Reddish brown with black borders and veins, and a transverse band across the middle of the hind wings . . *L. disippus.*
Velvety black, with metallic blue shades and spots . . . . . . *L. astyanax.*

18. Regal Fritillary (*Argynnis idalia*).

Found during July and August in swampy meadows or adjacent fields, and it is sometimes common locally. When feeding, the butterfly nervously flutters its wings and darts off at the least disturbance. It is single-brooded, and hibernates as a caterpillar. The caterpillar feeds on violets.

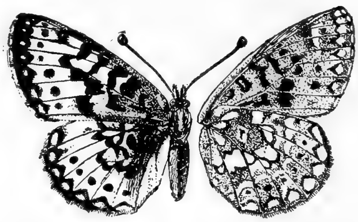


19. Great Spangled Fritillary (*Argynnis cybele*).

Rather common in swampy places. Makes its appearance in the latter part of June, and is found throughout July and the early part of August. The caterpillar lives on violets and hibernates.

20. Silver-Spotted Fritillary (*Argynnis aphrodite*).

Orange-brown with black spots. Closely allied to *A. cybele*, but may be separated from that species by its smaller size and the absence of the dark basal area on the fore wings above in the male, and also by the narrower yellow field between the outer margin and the brown basal color on the under side of the hind wings. It is found in wet meadows and overgrown fields in June and July. The caterpillar hibernates. It feeds on violets.



21. Silver-Bordered Fritillary (*Argynnis myrina*).

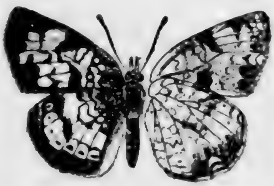
A small orange-brown butterfly, with black markings and silver spots on the hind wings beneath. It is common in swampy places and damp meadows. It is on the wing from the latter part of May until early in September, and it is triple-brooded. It flies rather slowly amongst tall grass, when not feeding. When alarmed, it flies only a short distance, and then settles again in the grass. The caterpillar feeds on the violet. Those of the last brood hibernate.

22. Meadow Fritillary (*Argynnis bellona*).

Common in this neighborhood and found together with *Argynnis myrina*, but it is not as abundant as the latter. In general appearance it very much resembles *A. myrina*, from which it differs in the absence of the silver spots on the hind wings beneath. The caterpillar feeds on the violet. The last brood of caterpillars hibernates.

23. **Variegated Fritillary** (*Euptoieta claudia*).

Not common in the vicinity of New York. It is found usually in damp, open places where the species of *Argynnis* occur. There are probably two broods here, one in June and July and the other in August and September. The caterpillar feeds on violet, mandrake, passion-flower etc.



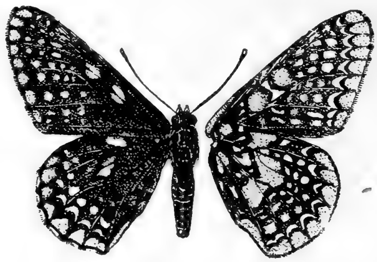
24. **Pearl Crescent** (*Phyciodes tharos*).

Very common from May to the latter part of September or early October. The form which appears in May and June is called *marcia*; it produces the summer form, *morpheus*. It is found in open meadows and fields, and is probably three-brooded in this vicinity. The caterpillar hibernates. It feeds on various kinds of asters.

25. **Silver Crescent** (*Phyciodes nycteis*).

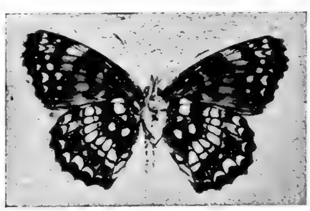
In general appearance this butterfly resembles *Phyciodes tharos*,

especially in color and markings on the upper side; but the under side of the hind wings is very different, being provided with silvery white bands and crescent-shaped spots, which are absent in *P. tharos*. It is also larger than that species. It is somewhat rare in this vicinity. It is on the wing in June and July. The caterpillar lives on different kinds of asters and sunflowers.



26. Black Checker Butterfly (*Melitæa phaëton*).

This pretty black species, with yellow and brick-red spots, is single-brooded, and is not rare in this vicinity, but is local in swampy places. It is found on the wing about the middle of June. In flight the butterfly is slow and sluggish. It alights on leaves, shrubs and grasses and on the ground. The eggs are laid in masses. The young caterpillars spin a web, in which they live until the following spring; after the caterpillars become older they leave the web and live singly on the leaves. Their food is turtle head (*Chelone glabra*), woodbine (*Lonicera*), *Gerardia* etc.

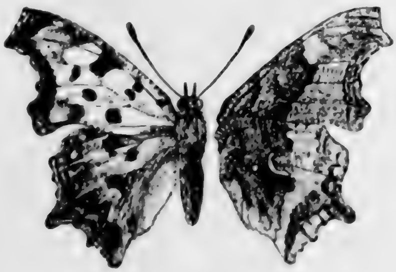


27. Harris's Butterfly (*Melitæa harrisii*).

Very rare in this neighborhood. On the upper surface it looks very much like *Phyciodes nycteis*, but the under surface is quite different. It is on the wing from about the middle of June until August. The caterpillar feeds on the aster.

28. Violet-Tip (*Polygonia interrogationis*).

Found in glades, gardens and roadsides in the vicinity of woods. It is very fond of sucking the sap which flows from wounded trees, especially maples and oaks, and is attracted by juices of decaying fruits. When at rest on the trunk of a tree, it is very difficult to detect, owing to the brown color of the under side of the wings, which closely resembles that of the bark of the tree or of a withered leaf. It is rather common during warm weather, but difficult to capture. In this vicinity there are three broods, the last one hibernating in the butterfly state. This butterfly has two forms; the hibernating one being known as form *fabricii* and the other as *umbrosa*. *Fabricii* has the upper sides of all the wings orange-brown, with pale and black spots. The form *umbrosa* has the hind wings very dark brown with the markings obliterated. The caterpillar lives on elm, hackberry (*Celtis*), hop and nettle.



29. Hop Merchant or **Comma Butterfly** (*Polygonia comma*).

A very wary insect with a quick, nervous flight, yet at the same

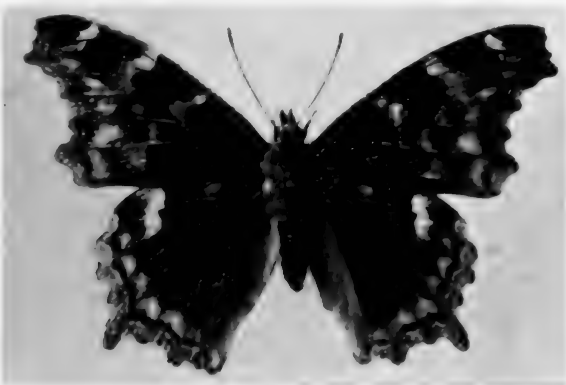
time audacious and pugnacious. It darts recklessly at and about objects in the air, vainly pursuing even a passing bird or dragonfly. They tussle with one another too to such an extent that their wings are almost invariably rubbed and broken after their wrangle. When disturbed, the butterfly takes a zigzag trip over a tree, house-top or fence, often without alighting anywhere, and returns to within a few inches of the old spot. The butterfly usually takes his pastime toward sunset, when only now and then a patch of sunlight remains among the shadows of the trees. The caterpillar is sometimes very destructive to hop vines, and in some localities it is known to growers as the "Hop Merchant," and according as the metallic color on the chrysalis is gold or silver, the price of hops will be high or low. This insect is quite common in the vicinity of New York. The hibernating form of this butterfly is called *harrisii* and the summer form *dryas*. The former differ from the latter in having the hind wings above considerably paler. It feeds on the elm and false-nettle (*Bœhmeria*), as well as on the hop-vine. The butterfly has a silver comma on the under side of the hind wing, hence the name "Comma Butterfly."

30. Marbled Comma Butterfly (*Polygonia faunus*).

Very rare in this vicinity. It is a northern insect, and is common in mountainous districts. It may be recognized easily by the deeply incised and notched outer margins of the wings; and by the under side of the wings, which is beautifully marbled with various shades of brown, from light to dark, and mottled with gray-white. In the light shade there is a row of olive-green spots, followed by a band of the same color within the outer border. The caterpillar lives on birch (*Betula lenta*), willow and wild and cultivated gooseberry.

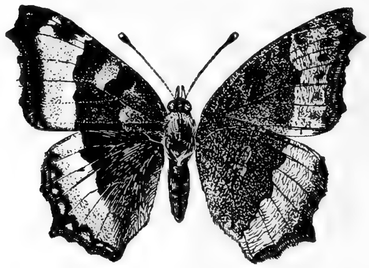
31. **Gray Comma Butterfly** (*Polygonia progne*).

The upper side of the wings is similar to that of *P. comma*, but the under side is very different; these are gray-brown, closely streaked with fine, short lines. It is less common than *P. comma*, but its habits are much the same. It is double-brooded, the first brood appearing in early summer and the second in August and September. The second brood hibernates. The caterpillar feeds on wild and cultivated currant and gooseberry. The figure shows the under side.



32. **White J Butterfly** (*Polygonia j-album*).

This species is somewhat rare in the vicinity of New York. In the Northern States the butterfly is abundant. It is yellowish, washed with rusty brown; basal half ferruginous, beyond which are large black spots on the fore wings and a white spot near the tip of each wing.



33. **American Tortoise-Shell Butterfly** (*Vanessa milberti*).

Somewhat rare in this vicinity, but common throughout the Northern States and Canada, and westward to the Pacific. The eggs are laid in masses, usually on the under side of the leaves of the nettle, and the caterpillars live in swarms.

34. **Mourning-Cloak Butterfly** (*Vanessa antiopa*).

This species hibernates in the butterfly state in sheltered places. It may be found under stones, stumps of trees, sticking to the rafters of barns or in the crevices of walls, sometimes huddled together in numbers, with the wings doubled together above the back, and apparently lifeless. During the first warm days of April and May the insects crawl forth from their winter quarters and hover about the sappy stumps of recently felled trees. About the middle of July the

butterfly becomes scarce, and remains so until the advent of the second brood, in August. The female deposits her eggs in a cluster around a twig near the petiole of a leaf. The caterpillars are gregarious in habits, living together in companies. The first brood of caterpillars appears in June and the second in August. The butterfly is velvety brown with pale yellow border. It is distributed over the entire breadth of the northern hemisphere below the Arctic circle, as far as the thirteenth parallel of latitude. The caterpillar lives on elm, willow, poplar and hackberry (*Celtis*).

A group of this species is on exhibition in the Hall of North American Forestry.

35. **Thistle Butterfly** (*Pyrameis cardui*).

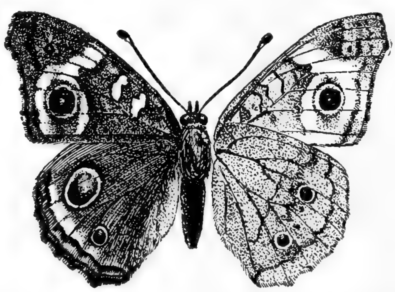
A cosmopolitan species, very common everywhere. In this vicinity it is doubled-brooded, and the caterpillar lives snugly within a few leaves spun together with silken threads. It lives on the thistle, burdock, sunflower and hollyhock.

36. **Painted Beauty** or **Hunter's Butterfly** (*Pyrameis huntera*).

This butterfly may be recognized at once by the white net-like marking and large eye-like spots on the under surface of the hind wings. Common in open fields and along roadsides. It is double-brooded and flies from May to October. The caterpillar feeds on cudweed (*Gnaphalium*) and on wormwood (*Artemisia*); it draws the leaves or flowers together and forms a rude case, within which it lives. The species is found throughout the United States and Canada.

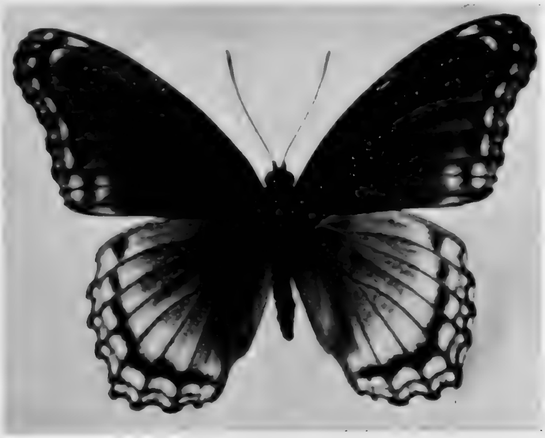
37. **Red Admiral** (*Pyrameis atalanta*).

Occurs over all North America and in Europe. In this vicinity it is sometimes very common, from the latter part of May until November, and it is double-brooded. The butterfly is brown with a broad red band across each wing. It is found usually along wood paths or in open woods and fields. The caterpillar draws together the edges of a leaf and forms a commodious cavity which shelters it. It feeds on nettle, hop and false nettle (*Bœhmeria*).



38. **Buckeye Butterfly** (*Junonia cœnia*).

Sometimes rather common in this neighborhood. The species may be recognized easily by the four eye-like spots on the upper side of the wings. The caterpillar feeds on *Gerardia*, plantain and snap-dragon. It is double-brooded. Found throughout the United States and southward.



39. **Blue Viceroy** (*Limenitis astyanax*).

This butterfly frequents orchards and feeds on fallen fruit. It is black with a bluish lustre, and the hind wings are clouded with bluish shades. It is double-brooded, the first brood appearing in May and June and the second in July and August. The caterpillar feeds on apple, thorn, gooseberry, cherry, plum, huckleberry etc.

40. **Brown Viceroy** (*Limenitis disippus*).

In general appearance this butterfly resembles *Anosia plexippus*, but may be distinguished therefrom at once by its smaller size, scalloped outer borders and the black band across the middle of the hind wings. It is common in this vicinity, where it is found usually along the borders of damp places and in waste fields. It is double-brooded, the first brood appearing in June and the second in July and August. The young caterpillar of the last brood rolls the tip of a leaf around itself, remains thus enclosed all winter and completes its transformation the following spring. It feeds on poplar, willow, apple, plum and oak.

Subfamily Satyrinæ.

The species of this subfamily are chiefly found in woods, glades and lanes, not often being seen in clearings or open fields. The flight of the butterflies is low, feeble and dancing in style, and is not long sustained. In color they are nearly always brown, with or without eye-like spots, above or below. The caterpillars are furnished with a fork-like process at the end of the body. Their food is different kinds of grasses. The species may be distinguished by the use of the following table:

Synopsis of the Satyrinæ.

Neonympha.

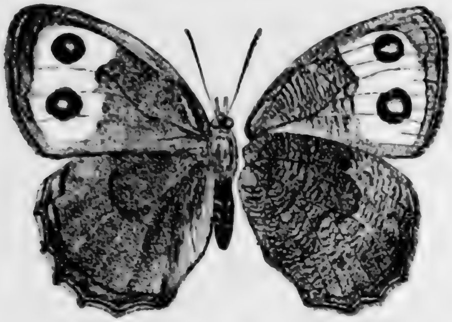
Outer borders rounded.
    Wood-brown, with two eye-like spots in yellow rings
        on each wing.................................*N. eurytus.*
    With a row of black spots in a light shade on each wing, *N. canthus.*

Debis.

Outer borders scolloped.
    With a row of black spots in a light shade on each
        wing.......................................*D. portlandia.*

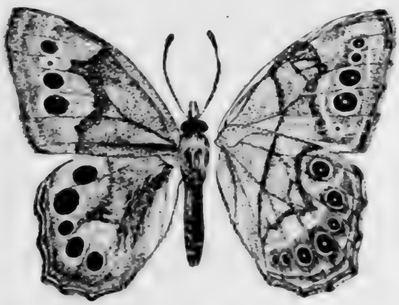
Satyrus.

Wood-brown, with yellow figure-8-like patch on the fore
        wings..*S. alope.*
    With yellow patch reduced and darker..........form *maritima.*
    With yellow patch absent......................form *nephele.*



41. **Blue-Eyed Grayling** (*Satyrus alope*).

Found plentifully throughout July and August in grassy fields and open woods, especially along the borders of woods where the large trees have been felled and a young growth is appearing. It flies low, and for but a short distance, and rests upon the leaves of bushes or trunks and twigs of dead trees. In the North a form occurs which lacks the yellow marks on the fore wings (var. *nephele*). The caterpillar feeds on grasses.



42. **Pearly-Eyed Grayling** (*Debis portlandia*).

Generally distributed in this vicinity, but it is local. The flight is somewhat like that of *Neonympha canthus*. It often rests on the trunks of trees, sallies forth at any passing butterfly and retires again to its chosen post of observation. It also flies near the ground, along the edges of woods or in the forests among bushes and trees. Found from the latter part of June to about the first of August, and it is single-brooded. The caterpillar feeds on grasses.

43. **Eyed Grayling** (*Neonympha canthus*).

Found in the latter part of June and through July and August, flying in swampy places. Its flight is low, with a slow, jerky motion. It settles here and there among the tall grasses. By beating the grass one may often start the butterflies in numbers. The caterpillar hibernates. It feeds on grasses.

44. **Little Wood-Satyr** (*Neonympha eurytus*).

Common from the latter part of May until August, in woods and near-by fields, especially fields more or less overgrown with shrubs. It is single-brooded. The caterpillar feeds on grasses.

Subfamily LIBYTHEINÆ.

The species belonging to the subfamily *Libytheinæ* are characterized by their long, beak-like, palpi (mouth parts), and by the males having four feet adapted for walking, while the females have six. They are commonly known as Snout-Butterflies. Only a single species is found in the vicinity of New York.

45. **Snout Butterfly** (*Libythea bachmani*).

This species may be recognized easily by its long beak-like palpi, hence the name Snout Butterfly. It is somewhat rare here, though it sometimes appears in numbers. It flies during May, July, August and early September, and is two- or three-brooded. The caterpillar feeds on hackberry (*Celtis*).

Family LYCÆNIDÆ.

These are small butterflies, with or without fine, short, hair-like tails on the hind wings. They have six legs adapted for walking. They are commonly called Blues and Hair-Streaks. The caterpillars usually live in flower-heads of various kinds of plants, feeding on the tender parts of the leaves only when compelled to do so. They are more or less oblong oval or oval, with the head retractile into the first segment, and have a ridge along the back. The chrysalids are short, fastened at the anal extremity, and have a loop of silk around the body, much as do the *Papilionidæ*. They may be separated as follows:

Synopsis of the Lycæninæ.

Thecla.

Hind wings with tails.
- Slate-gray, with an orange spot at the anal angle of hind wing..*T. melinus.*
- Sepia-brown, with a double, broken, white transverse band on both wings beneath..................*T. calanus.*
- Sepia-brown, with four irregular, wavy white lines across the upper wing beneath......................*T. strigosa.*

Thickly scaled with green on the under side, with wavy white and brown transverse bands . . . . *T. damon.*
Hind wings strongly toothed or notched.
Outer half of hind wings heavily overlaid with whitish scales beneath . . . . *T. irus.*
Hind wings ferruginous with zig-zag transverse lines beneath . . . . *T. niphon.*
Hind wings not toothed or notched.
Under side of hind wings with outer half ferruginous . . *T. augustus.*
Hind wings with outline evenly rounded (female); hind angle produced (male).
Under side of hind wing with an outer row of large orange spots . . . . *T. titus.*

Feniseca.

Wings ochraceous, with black border.
Under side of hind wings with many whitish rings . . *F. tarquinius.*

Chrysophanus.

Small size, glossy orange-red.
Hind wing brownish-gray with black spots beneath. *C. hypophlæas.*
Large size, copper-brown with black spots.
Under side of wings whitish, with black spots . . . . *C. thoë.*

Lycæna.

Hind wings with a thread-like tail. Color, blue.
Under side of hind wings with two orange spots . . . . . *L. comyntas.*
Hind wings without thread-like tail. Color, blue.
With terminal row of orange spots on under side of hind wings . . . . *L. scudderii.*
Without orange spots on hind wings beneath . . . . *L. pseudargiolus.*
Smaller than *pseudargiolus* . . . . form *neglecta.*
Spots on under side running together . . . . form *lucia.*
Spots on basal area of hind wings not running together, form *marginata.*
Terminal rows and basal spots on hind wing prominent, not running together . . . . form *violacea.*

46. Gray Hair-Streak (*Thecla melinus*).

A small slate-colored species, with an orange patch, enclosing a black spot, near the anal angle of the hind wings. It is double-brooded, and flies in open woods and gardens during May, June, July and August. The caterpillar lives on the heads of the common hop-vine, and also on the bean.

47. Banded Hair-Streak (*Thecla calanus*).

Not common in the vicinity during June, July and August, in woods and about shrubbery. The butterfly is sepia-brown above, and on the under surface, with two double white stripes on each of the fore and hind wings. It is single-brooded. The caterpillar feeds on oak, chestnut, hickory and walnut.

48. Striped Hair-Streak (*Thecla strigosa*).

Very rare in this vicinity. It is closely allied to *T. calanus*, but differs in the position and number of white lines on the under side. The butterfly appears to be local, and is rarely found away from thickets. It flies early in July, and is rarely found on the wing after the first of August. The eggs are laid in July and remain unhatched until spring. The caterpillar feeds on oak, holly, thorn, plum and apple.

49. **Hoary Hair-Streak** (*Thecla irus*).

Rather common locally in this neighborhood, especially in pine woods and open places near where huckleberries grow. The caterpillar is said to feed on these plants. It lives on the wild plum also. The butterfly appears during the latter part of April, and is on the wing until about June.

50. **Coral Hair-Streak** (*Thecla titus*).

The butterfly frequents flowers in open sunny places near thickets and woods. It is found in July and early in August, and is single-brooded. In this vicinity it is considered rare, but occasionally it has been found in considerable numbers. Its color is sepia-brown, with a row of coral-red spots along the outer border on the under sides of the hind wings. The caterpillar lives on plum and wild cherry.

51. Green Hair-Streak (*Thecla damon*).

Found on the wing in May and June, and again in July and August. It occurs only in localities where cedar trees grow, this tree furnishing the food of the caterpillar. The butterfly when disturbed flies for a short distance and suddenly drops to the ground, folding its wings. Owing to the green color on the under side of the wings, it is quite difficult to detect the insect in the grass.

52. Brown Elfin (*Thecla augustus*).

In color on the upper surface this insect is like that of *T. irus*, but it differs greatly from that species as to the under side of the hind wings, which have the basal half deep brown and the outer half rusty brown, with a row of minute dark spots. It is found in pine woods in April and May.

53. Pine Hair-Streak (*Thecla niphon*).

Rare in this vicinity. Found in pine woods, in April and early in May. It is single-brooded. The caterpillar feeds on pine.

54. Tailed Blue Butterfly (*Lycæna comyntas*).

A small blue butterfly common everywhere, in meadows, clover fields and roadsides from May to September. It is three-brooded, and the caterpillar feeds on the flower-heads and tender leaves of clover, bush-clover (*Lespedeza*) and tick-trefoil (*Desmodium*).

55. Scudder's Blue Butterfly (*Lycæna scudderii*).

Very rare in this neighborhood. Only a few specimens have been taken. It is double-brooded, the first brood appearing in May and June, and the second in July and August. The caterpillar feeds on lupines.

56. Spring Azure Butterfly (*Lycæna pseudargiolus*).

A very common species found in open sunny places, especially in woods. There are five forms of this butterfly in this vicinity. The forms *lucia*, *marginata* and *violacea* are found in April and early in May. The forms *neglecta* and *pseudargiolus* are found in the summer until September. The caterpillar lives in the flower-heads and tender leaves of various kinds of plants.

57. **American Copper Butterfly** (*Chrysophanus hypophlœas*).

Very common in open, sunny fields and meadows, from May to October. Three-brooded in this vicinity. The caterpillar lives on sorrel (*Rumex*).

58. **Bronze Copper Butterfly** (*Chrysophanus thoë*).

This butterfly is double-brooded, and is not common in this vicinity. It is found in swampy places. The first brood appears in June or early in July, and the second from the middle of August to the middle of September. The caterpillar feeds on smart-weed (*Polygonum*) and sorrel (*Rumex*).

59. **The Wanderer** (*Feniseca tarquinius*).

Somewhat rare and local in this neighborhood. It is usually found where alders grow. The caterpillar feeds on plant-lice, which live in masses and are covered with thick white waxy excretions. The caterpillar particularly affects the species (*Schizoneura tessellata*)

which occurs on the alder. It is three-brooded, the first brood appearing from the latter part of May to the middle of June; the second early in July, continuing to fly until the early part of August; the third brood appears from the middle of August to the end of September.

Family HESPERIDÆ.

The members of this family are known as Hesperids or Skippers, the latter name having been applied on account of the peculiar flight of the species. The flight is very rapid, varied and interrupted, terminating suddenly after a short career and suddenly resumed. It is hurried and intermittent, never steady or sailing like that of the other groups. The butterflies almost invariably delight in the hottest sunshine, and generally frequent open meadows. They may be known readily by their antennæ, which are abruptly hooked at the tip. The caterpillars have between the head and first segment a distinct neck which gives them a very characteristic appearance.

Synopsis of the Hesperidæ.

Ancyloxpyha.

Fore wings blackish, washed with orange, ochraceous.
Under side of hind wings clear orange, ochraceous . . . *A. numitor.*

Pamphila.[1]

With a short black bar on fore wings at end of cell.
Under side of hind wings with a large yellow patch in the middle . . . . *P. hobomok.*
Under side of hind wings almost entirely yellow, brown at base . . . . *P. zabulon.*

[1] It is very difficult to give a satisfactory synopsis of the genus *Pamphila*, as the sexes of each species differ in markings on the upper side, especially on the fore wings. The males of some species are provided with a stigma, which is more or less distinct or wanting entirely; while in the females it is always absent. The markings and coloration of the under side of the hind wings, however, are constant in both sexes, and by means of this they may be readily united, or the species separated. The stigma is a velvety mark on the fore wings.

Under side of hind wings clear yellow................*P. logan.*

With an oblique velvety black stigma on fore wings (male).

Under side of hind wings yellowish with an indistinct spot-like band in the middle..................*P. sassacus.*

Under side of hind wings rusty brown with a conspicuous row of white or pale yellow spots...........*P. leonardus.*

Under side of hind wings yellowish, with black spots..*P. phylæus.*

Under side of hind wings with a distinct, yellow, large spot-like band across the middle connected with a patch at the base...........................*P. peckius.*

Under side of hind wings with a more or less distinct, yellow, spot-like band in middle, not connected with the patch near base......................*P. mystic.*

Under side of hind wings thickly scaled with olivaceous .*P. cernes.*

With stigma on fore wings indistinct.

Under side of hind wings vinous, with a few very indistinct, paler spots in the middle...................*P. verna.*

Under side of hind wings lighter brown than upper..*P. metacomet.*

Under side of hind wings rusty brown, with violet patches, *P. accius.*

With stigma on the fore wings curved.

Under side of hind wings dirty yellowish, with a lighter shade in the middle..................................*P. huron.*

Stigma on fore wings pinched in the middle.

Under side of hind wings orange-brown, with a few yellow spots in the middle......................*P. pontiac.*

With stigma connected with an indistinct, narrow basal streak.

Under side of hind wings ochraceous, with a row of lighter spots in the middle......................*P. manataaqua.*

Stigma broken in the middle.

Under side of hind wings rusty brown, with a row of lighter spots in the middle, or olive-brown ......*P. otho* var. *egeremet.*

Stigma absent.

Under side of hind wings with a large, bright yellow patch in the middle.......................*P. massasoit.*

Both sexes similar; under side of hind wings dirty yellowish-brown, with a lighter patch in the middle....................................*P. viator.*

Stigma minute, almost invisible.

Under side of hind wings washed with gray..........*P. hianna.*

Fore wings dark brown, with bronzy lustre and two semi-transparent spots in the middle.
Under side of hind wings paler than the upper, with a lighter reflection.............................. *P. ocola.*
Fore wings brown without spots.
Hind wings with white fringes........................ *P. fusca.*

Pyrgus.

Black, with transverse rows of white spots on the fore wings, *P. tessellatus.*
Black, with one row of transverse, white spots........ *P. centaureæ.*

Pholisora.

Sooty black, with an irregular curved row of small white dots.................................. *P. catullus.*

Nisoniades.

Deep brown, fore wings thickly scaled with gray between the outer bands.................................. *N. brizo.*
Smaller, with the scales more regularly distributed over the fore wings.................................. *N. icelus.*
Small, with white spots on the outer band............... *N. lucilius.*
Larger, marked like *lucilius* but less distinctly........... *N. persius.*
With bands on fore wings heavy and very conspicuous, white spots very indistinct.................. *N. martialis.*
Large species, allied to *martialis*, but with heavy white spots.................................. *N. juvenalis.*

Eudamus.

Chocolate-brown, with an amber-yellow patch on fore wing.
Under side of hind wings with a large silvery-white spot in the middle.......................... *E. tityrus.*
Under side of hind wings broadly smeared with white along the outer border........................ *E. lycidas.*
Under side of hind wings with two transverse bands.
Fore wings with small white spots.................. *E. pylades.*
Fore wings with large white spots.................. *E. bathyllus*
Fore wings with a broad, oblique, amber-yellow band.
Outer border of hind wings scaled with gray........... *E. cellus.*
Hind wings with long, tail-like appendages.
Wings and body above with long green hairs......... *E. proteus.*

60. **Small Skipper** (*Ancyloxypha numitor*).

A small orange-brown species with black borders. Common in marshy grassy places in June, July, August and September, and is three-brooded. The caterpillar feeds on grasses.

61. **Massasoit Skipper** (*Pamphila massasoit*).

Flies in swampy places in June and July, and is sometimes common locally. The caterpillar feeds on grasses.

62. **Logan Skipper** (*Pamphila logan*).

Rare in this vicinity, but common in the Southern States. Found from June until September. The caterpillar feeds on grasses.

63. **Zabulon Skipper** (*Pamphila zabulon*).

Differs from *P. hobomok* by having the under side of the hind wings almost entirely bright lemon-yellow with the base brown. The female is always brown and resembles var. *pocahontas*.

64. **Hobomok Skipper** (*Pamphila hobomok*).

Rather common along the edges of woods and sunny wood paths, during the latter part of May and throughout June, disappearing early in July. It is single-brooded. It flies close to the ground, and settles on leaves of plants when at rest. In the female a form occurs (var. *pocahontas*) which is brown instead of yellow. The caterpillar feeds on grasses.

65. **Leonard's Skipper** (*Pamphila leonardus*).

Rather scarce in this neighborhood. Single-brooded. It is on the wing during the latter part of August until early in September. The caterpillar feeds on grasses.

66. **Huron Skipper** (*Pamphila huron*).

Somewhat rare, but common farther south. It is single-brooded. The caterpillar feeds on grasses.

67. Sassacus Skipper (*Pamphila sassacus*).

Not common in this vicinity in May and June. It occurs along roadsides and borders of woods. The caterpillar feeds on grasses.

68. Mystic Skipper (*Pamphila mystic*).

Rather common locally. Found in open grassy meadows late in May and throughout June, and again in August and early September. The caterpillar feeds on grasses.

69. Common Skipper (*Pamphila cernes*).

Very common everywhere from May to September in grassy meadows. It flies usually in company with *P. peckius*. Double-brooded. The caterpillar feeds on grasses.

70. Brown Skipper (*Pamphila fusca*).

A small, uniformly brown species with the fringes on the hind wings whitish. It is rare in this vicinity, and is found in sandy places. In the Southern States it is quite abundant.

71. Egeremet Skipper (*Pamphila otho*, var. *egeremet*).

Sometimes rather abundant locally in June and July. The form *otho* is common in the Southern States and does not occur in this vicinity. The caterpillar feeds on grasses.

72. Metacomet Skipper (*Pamphila metacomet*).

Not common. Found in June and July. It frequents flowers in fields and open ground. Single-brooded. The caterpillar feeds on grasses.

73. Hianna Skipper (*Pamphila hianna*).

Appears during the latter part of May, and is on the wing until about the middle of June. A brown butterfly with a few white dots on the fore wings, and heavily shaded with gray on the under sides of the wings. Very rare in this vicinity.

74. Peck's Skipper (*Pamphila peckius*).

Found everywhere in meadows, and is one of the most common species of Hesperids in this vicinity. It is double-brooded, the first brood appearing from the latter part of May to the middle of July, and the second brood in August and September. The caterpillar feeds on grasses.

75. Pontiac Skipper (*Pamphila pontiac*).

Not common. Found in June and July. It is single-brooded. The caterpillar feeds on grasses.

76. Ocola Skipper (*Pamphila ocola*).

A dark-brown species, with slight bronzy lustre. There is a semi-transparent spot on the fore wings at the end of the cell, and a small dot a little beyond. Sometimes traces of a third spot are found beneath the large one. Very rare in this vicinity, but common southward.

77. **Spotted Skipper** (*Pamphila phylæus*).

Rare in this vicinity, but it is a common insect in the Southern States. The caterpillar feeds on grasses.

78. **Clouded Skipper** (*Pamphila accius*).

Very rare in this vicinity, but a common insect in the Southern States. It is deep brown, with violet shades on the under surface of the hind wings. Found in June and July.

79. **Glass-Spotted Skipper** (*Pamphila verna*).

Common, but not abundant, in June and July. Flies in grassy meadows. It is single-brooded. The caterpillar feeds on grasses.

80. **Manataaqua Skipper** (*Pamphila manataaqua*).

Found in June, July and August. It is single-brooded. The butterfly in general appearance looks very much like *P. cernes*, but it is considerably larger, and on the under side of the hind wings there is a row of pale spots. The caterpillar feeds on grasses.

81. **Broad-Winged Skipper** (*Pamphila viator*).

Scarce in this neighborhood. It is single-brooded, and is on the wing in June.

82. **Checkered Hesperid** (*Pyrgus tessellatus*).

Not common in this vicinity. Appears to be triple-brooded, being found from the latter part of April until October The caterpillar feeds on mallow, *Sida*, Indian mallow (*Abutilon*) and marshmallow (*Althæa*).

83. **Grizzled Hesperid** (*Pyrgus centaureæ*).

Common locally, and is on the wing during the latter part of April and until about the middle of August. The butterfly has a remarkable distribution. It is found in Lapland, Scandinavia, Labrador, and from the Canadian hills and Vermont to North Carolina. The early stages are unknown.

84. **Sooty Skipper** (*Pholisora catullus*).

Very common everywhere in open fields, gardens, roadsides and meadows. It is double-brooded, and flies from May until September. The caterpillar feeds on goosefoot (*Chenopodium*); it draws the leaves together with silken threads, making a case within which it lives.

85. *Nisoniades brizo.*[1]

Found in May and June in moist, shady woods and along wood paths. The butterfly flies swiftly and near the ground. It is single-brooded. The caterpillar feeds on oak.

86. *Nisoniades lucilius.*

Rather common locally in open woods and roadsides, in May and June. Single-brooded. The caterpillar feeds on wild columbine (*Aquilegia*).

[1] The butterflies belonging to the genus *Nisoniades* are known commonly as "Dusky-wings."

87. *Nisoniades icelus.*

Not rare in open woods, and especially along wood paths. It flies during May and June. It is single-brooded. The caterpillar feeds on aspen, willow and witch-hazel.

88. *Nisoniades persius.*

Allied to *N. lucilius*, but is larger, with the markings less distinct. It is quite common locally, in woods and along shady roadsides. It is single-brooded and flies during May and June. The caterpillar feeds on willow and poplar.

89. *Nisoniades martialis.*

Quite scarce in this vicinity, and found in localities similar to those in which are found other species of *Nisoniades*, in May and June, and again in July and August. The food-plant is said to be wild indigo (*Indigofera carolina*).

90. *Nisoniades juvenalis.*

A common species found from May until the end of August, especially in oak woods or roads near by. It is double-brooded.

91. Golden-Banded Hesperid (*Eudamus cellus*).

Exceedingly rare in this neighborhood, but more common in the Southern States and Mexico.

92. Northern Cloudy-Wing (*Eudamus pylades*).

Common in open woods and fields near by; it flies rapidly, close to the ground, and it is single-brooded. Found from the latter part of May to the middle of August. The caterpillar feeds on clover and bush-clover (*Lespedeza*).

93. **Southern Cloudy-Wing** (*Eudamus bathyllus*).

Found during June and July in the same places as *E. pylades*, but it is less common. It is single-brooded. The caterpillar feeds on wild bean, bush-clover (*Lespedeza*), butterfly-pea (*Eutrosema virginianum*), hoary pea (*Tephrosia*) and probably other plants belonging to the family *Leguminosæ* (Pulse family).

94. **Silver-Spotted Hesperid** (*Eudamus tityrus*).

Common everywhere in this vicinity, from May to September. Double-brooded. The caterpillar feeds on locust, acacia, wistaria, milk-vetch (*Astragalus*), tick-trefoil (*Desmodium*) and wild bean (*Apios*).

A watercolor painting showing a branch of a locust-tree with male and female butterflies, the caterpillar and the chrysalid of the Silver-Spotted, or Locust, Hesperid and illustrating the effect of the insect on the leaf is on exhibition in the Hall of North American Forestry.

95. **Hoary Cloudy-Wing** (*Eudamus lycidas*).

Not common. It may be found in June and July in open places and edges of woods. The flight of the butterfly is swift, and it darts off very rapidly when disturbed. Besides alighting on flowers, it has the habit of sitting on the tips of dead branches of bushes and young trees. It is single-brooded. The caterpillar feeds on tick-trefoil (*Desmodium*) and other *Leguminosæ*.

96. **Long-Tailed Hesperid** (*Eudamus proteus*).

Exceedingly rare in this neighborhood, but very common in the Southern States. The caterpillar feeds on wild bean (*Phaseolus*), butterfly-pea (*Clitoria*), wistaria, tick-trefoil (*Desmodium*) and other allied plants

THE AMERICAN MUSEUM JOURNAL.

EDMUND O. HOVEY, *Editor.*

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AMERICAN MUSEUM OF NATURAL HISTORY

The Sequoia

A Historical Review of Biological Science

BY

George H. Sherwood, A.M.

Assistant Curator

SUPPLEMENT TO AMERICAN MUSEUM JOURNAL

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Guide Leaflet No. 8

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THE FALL OF "MARK TWAIN"

THE FALL OF "MARK TWAIN"

The noble specimen of [illegible] which forms the subject of this paper was given to the Museum [illegible] by the late Collis P. Huntington. The Museum is indebted to Mrs. Collis P. [illegible] for the funds necessary for its preparation and installation.

THE SEQUOIA.

A Historical Review of Biological Science.

By George H. Sherwood, A.M.,
Assistant Curator, A. M. N. H.

The *Sequoia* constitute a group of trees which in past ages was abundant in temperate climates of Europe, Asia and America, but which during the glacial period were all but exterminated, only two living species, the "Redwood" (*Sequoia sempervirens*) and the "Big Tree" (*Sequoia gigantea*), surviving to represent the genus. Both are very limited in numbers and in distribution.

The Redwood is found only in a narrow tract of land extending from the southern border of Oregon to Monterey Bay, while the Big Tree is still more restricted, being confined to but ten isolated groves situated between the altitudes of 4000 and 8000 feet above the sea, on the western slope of the Sierra Nevada mountains (see accompanying map). This area is bounded on the north by the American river, and on the south by Deer Creek, and the total distance from the most northerly group (North grove) to the most southerly (Tule River grove) is only 260 miles. The King's River and Kaweah River grove is the largest both as to area and number of trees. The extent of this district is four or five miles in width, and eight or ten miles in length. It has a variation in altitude of 2500 feet. It is an interesting fact that as one proceeds from north to south the Big Trees flourish at higher and higher altitudes.

Quoting from Bulletin No. 28 of the United States Department of Agriculture (1900): "The Big Trees are unique in the world,—the grandest, the largest, the oldest, the most majestically graceful of trees,—and if it were not enough to be all this, they are among the scarcest of known tree species and have the extreme scientific value of being the best living representative of a former geological age." Professor Sargent describes the wood as follows: "The wood of the Big Tree is very light, soft, not strong, brittle, and coarse-grained, but very durable in contact

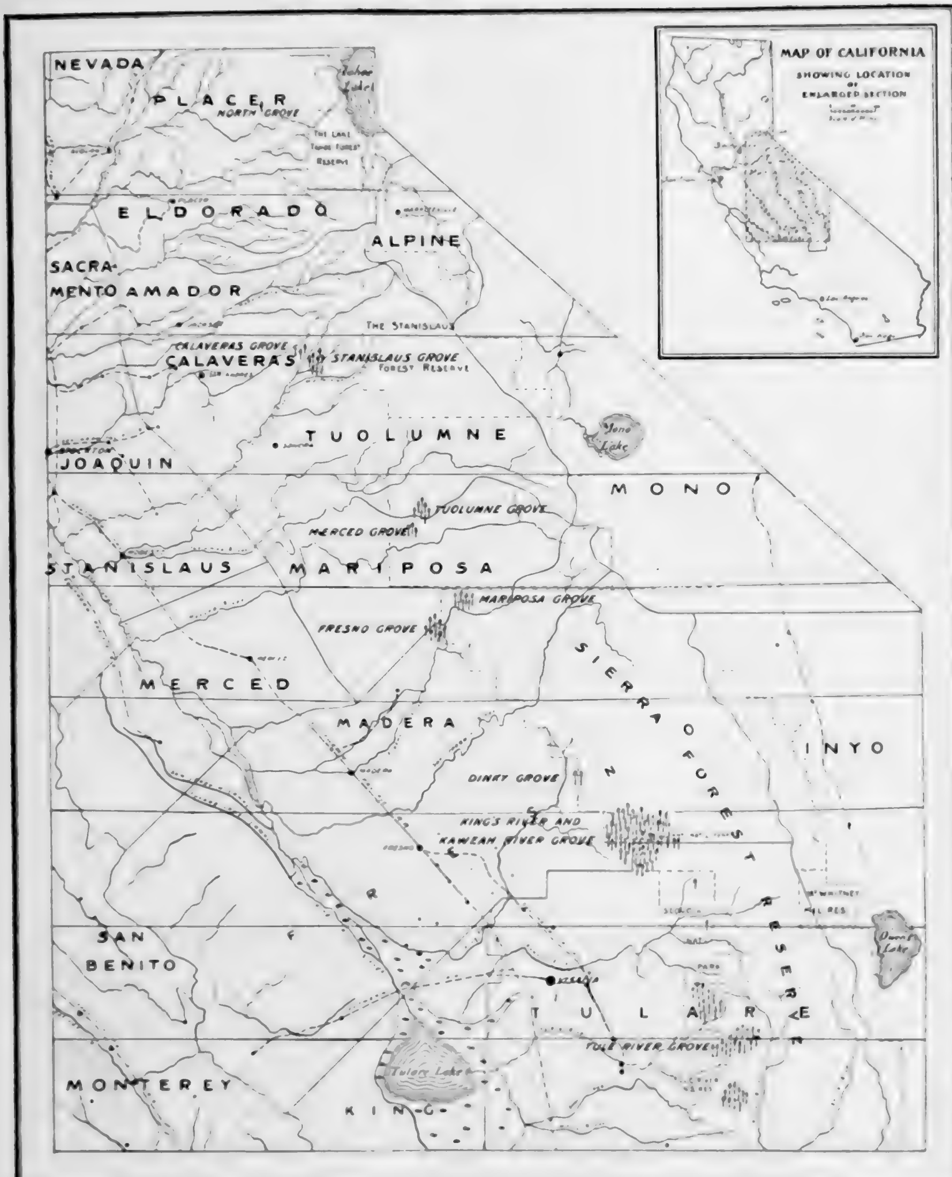
with the soil. It is bright clear red, turning darker on exposure, with thin, nearly white sapwood, and contains thin, dark colored conspicuous bands of small summer-cells and numerous thin medullary rays. The specific gravity of the absolutely dry wood is 0.2882, a cubic foot weighing 17.96 pounds. Manufactured into lumber, it is used locally for fencing and in construction, and is made into shingles."

The reproduction of the Big Tree is so slow and uncertain, and the methods of the lumbermen in cutting the timber so destructive, that it is probable that in a short time these veritable giants of the forest will become extinct, unless protected by law. Fortunately both the State and national governments control some of the groves, although not the grandest.

For the purpose of procuring a specimen of this remarkable tree for the American Museum of Natural History, S. D. Dill was sent to California in the summer of 1891. Through the courtesy and liberality of A. D. Moore, owner of one of the largest groves of Big Trees, and his son (manager of the King's River Lumber Company), Mr. Dill was permitted to select the tree he might desire. After diligent search, he found a fine specimen growing at an altitude of 7000 or 8000 feet and bearing the name "Mark Twain." Nearly all the large trees have been christened by hunters or tourists, and several are marked with marble tablets. Such names as "Bay State," "Sir Joseph Hooker," "Pride of the Forest" and "Grizzly Giant" are familiar.

"Mark Twain" was a tree of magnificent proportions, one of the most perfect trees in the grove, symmetrical, fully 300 feet tall, and entirely free of limbs for nearly 200 feet. Eight feet from the ground the trunk was 62 feet in circumference, while at the ground it measured 90 feet. Mr. Moore kindly took the contract of felling the tree and shipping to the Museum a section suitable for exhibition. The accompanying instantaneous photograph gives a vivid picture of the fall of this noble giant.

The section on exhibition was cut from the trunk about 12 feet from the base, and is 4 feet in thickness. Its estimated weight was 30 tons, and for easier transportation it was split into ten pieces. The face of the specimen as it now stands is 16 feet



MAP SHOWING DISTRIBUTION OF THE "BIG TREE"

An enlargement of the cross-lined area of the accompanying map of California. The relative sizes of the groves are indicated by the number of trees on the map.

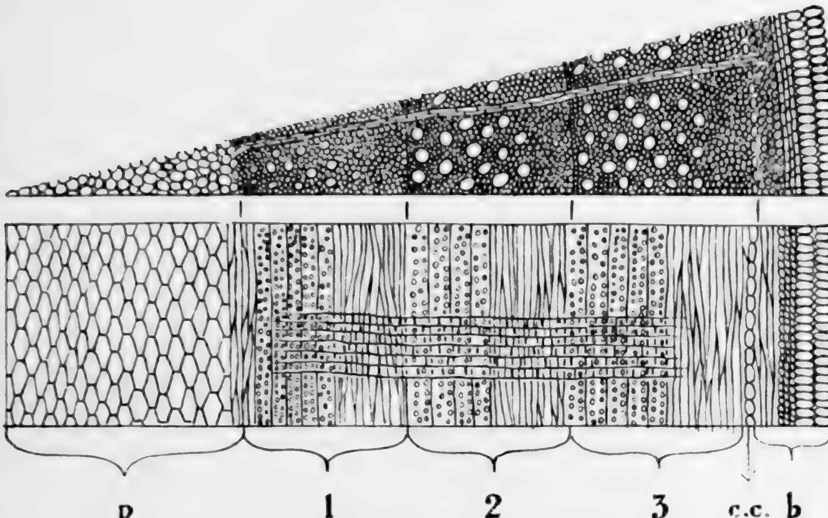


Diagram of the Structure of the Stem of an Exogenous Tree of Three Years' Growth

Modified from a cut in "Encyclopedia Britannica"
p, pith; cc, Cambium cells; b, bark; 1, 2, 3, growth of wood during first, second and third year.

2 inches in diameter, measured inside the bark, which in places is nearly a foot in thickness.

The Big Tree, like most trees of temperate climates, is exogenous, as is indicated by the concentric circles of wood beautifully shown in this specimen.

A transverse section of the stem of any exogenous tree of one year's growth consists of three distinct areas or zones. In the center is the pith, around this a ring of wood, and surrounding the whole the bark. Each of these layers consists of cells which are variously modified to carry on their respective functions. Uniting the bark and the wood are delicate thin-walled cells, filled with protoplasm and nutrient matter, which constitute the *zone of growth* of the tree. The innermost cells of this *Cambium layer*, as it is called, form the new wood, while the outermost renew the bark. The oldest wood, then, is that nearest the pith, while the oldest bark forms the exterior of the trunk. During the spring, when the sap is running, the multiplication of Cambium cells is very rapid, and consequently more wood and bark are laid down

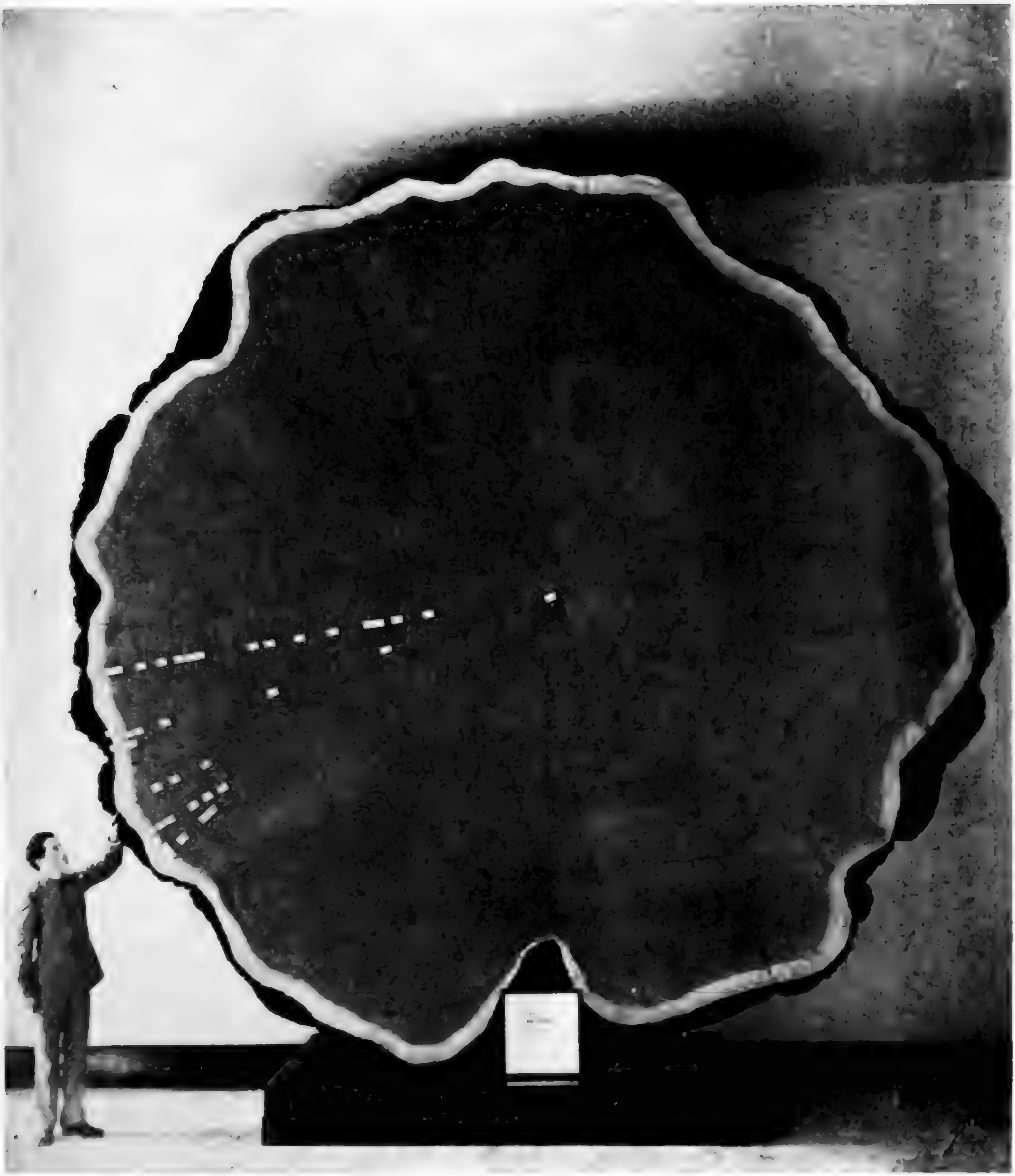
than during the fall and winter, when the tree receives little nutrition. These periods of interrupted growth are represented in trees of several seasons' growth by distinct lines separating the rings of wood. In the trees of cold-temperate climates, where the contrast of seasons is great, the rings of wood are very distinct, as, for instance, in the Big Tree. In many trees the increase in the wood forces the bark asunder, which, through the action of the weather, becomes rough and rugged. If it were not for the constant renewal of the inner layers by the Cambium cells, the bark might entirely disappear.

In the case of the wood it is quite different. The inner rings, which are the older, are entirely surrounded by the outer rings of fresh young sap-wood, by which they are protected from climatic changes. Every new circle of wood moves the zone of growth farther from the center. The central wood undergoes a change, its cell walls becoming thicker and the calibre of the ducts or vessels smaller. It usually takes on a different color from the sap-wood. This is now called heart-wood, although it performs no vital function in the life of the tree and is practically dead.

In some of the Big Trees much of the heart-wood has decayed and disintegrated, with no more injurious effect upon the tree than a weakening of the trunk. So much of the heart-wood had decayed in one specimen, which was blown down by the wind, that men on horseback were able to ride into the trunk a distance of seventy feet, and pass out through a hole in the side.

Injuries to the wood are sometimes repaired by the deposit of new layers of cells. It is even possible to determine the year when such injuries occur by merely counting the rings of repair. On the extreme right of the specimen in the Museum are two such wounds. In each of the two places marked with a cross a bullet was found, but the wounds had been covered by at least five years' growth of wood. That the bullets did permanent injury to the wood in the immediate vicinity is indicated by the change of sap-wood into heart-wood, which in these places extends nearly to the edge of the bark.

Since, therefore, the rings of wood correspond to periods of vegetable growth, which are seasonal, and the lines of separation



THE SECTION OF THE "BIG TREE" IN THE MUSEUM

The uppermost series of cards represents events in General History ;
The light cards immediately below represent changes of thought in the Philosophy of Biology ;
The small black cards mark the succession of centuries in the life of the tree ;
Of the cards below the black,
The first row indicates the advance of General Biology ;
The second, that of Comparative Anatomy ;
The third (one card) the discoveries of Palæontology ;
The fourth, the Progress of Embryology.

represent periods of interrupted growth, a tree carries its biography within itself. During more favorable seasons, the circles are wider, and the intensity of the winter intensifies the outlines of the rings.

"Mark Twain" upholds the reputation of the Big Tree for longevity. The rings show that it was 1341 years old when cut down in the fall of 1891. Thus it must have begun its life in A. D. 550, or only seventy-four years after the Fall of Rome. Practically all of medieval history, as well as modern, must be included in this period, while Natural Science or Biology may be said to have developed during its old age.

The small black cards which have been placed on the tree mark the successive centuries and give the growth of the tree during each hundred years. The uppermost row of white cards

1619

HARVEY

Discovers circulation of the blood

indicates political events and discoveries which have had influence on the progress of civilization since the year 550. The remainder show the progress in biology. The group immediately above the black cards represents the change in thought in philosophical biology, while those below give a history of biology proper.*

When the tree was a mere sapling, Europe was overrun by the Goths, Vandals and Franks, and a state of almost universal war prevailed. About twenty years later Mahomet was born,

* Each card is mounted on a pin which is stuck into the ring of growth corresponding to the date on the card. For example, in the accompanying sketch: 1619 is the year that William Harvey announced his discovery of the circulation of the blood. The pin attached to the card is inserted into the ring of wood which represents the growth of the tree during the year 1619. In some instances it has been necessary to put two dates on a card. In these cases the pin has been stuck into the ring of growth of the earlier date.

and then followed the establishment of the Mohammedan religion, which, during the next one hundred and fifty years, reached the zenith of its power and threatened to overrun the whole world. This Saracenic invasion was checked at the battle of Tours (732), in which the Franks under Charles Martel overwhelmingly defeated the Mohammedans. The beginning of the next century was marked with the crowning of Charlemagne on Christmas day, 800. This monarch made a noble effort to educate his people by establishing a school at his court and inviting thither the few learned men of his time.

The climatic conditions in California during A.D. 800 and the year preceding must have been very favorable for the growth of our tree, which had already attained the size of a large elm. Its growth during these two years, indicated by the large rings, was phenomenal.

During this century occurred also the effort of King Alfred to establish schools in England. The hardy Norsemen began their bold voyages in quest of treasure and adventure, colonized Iceland in 874, discovered Greenland (981), and pushing farther westward probably sailed down along the eastern shore of America.

The Crusades, begun in 1096 and continuing for almost 200 years, brought the various European peoples into intercourse, which resulted in exchange of ideas and helped prepare the popular mind for the discoveries which were soon to follow.

The first half of the thirteenth century saw the founding of the universities. First, the University of Paris (1200), which became the center of theology; a few years later were founded the University of Bologna, famous for law, and the University of Padua, which attracted the greatest students in medicine. In England, Oxford University was founded in 1249.

The fifteenth century brought those marvelous discoveries which were of so much importance in the advancement of civilization, and which contributed to the growth of science. Printing with wooden block type was introduced by John Gutenberg in 1438, and his invention was followed in 1450 with the use of metal type, making the general dissemination of knowledge possible.

Columbus' discovery of America (1492) was followed by Magellan's famous trip around the world to the westward (1519–1522), during which he discovered the Philippines; and about the same time Cortez conquered Mexico. The New World was soon explored for its reputed hidden treasures, and astronomers' search of the heavens for an orderly movement of planetary bodies resulted in the elaboration of the system of Copernicus (1543). Keppler announced his laws of planetary motion at about the same time (1609), and in the latter part of the seventeenth century Newton enunciated the law of gravitation. The increasing freedom of thought was expressed in the American and French Revolutions.

The rapid course of invention during the nineteenth century is too familiar to require detailed mention. The period of the tree's growth, however, is represented by only a few inches in its total diameter.

The cards representing the growth of biology are arranged in two groups. Those above the line of black cards represent the change of thought in the *philosophy* of biology, while those below the line indicate some of the great discoveries which have made the science what it is to-day. The latter have been divided into three rows, the uppermost representing General Zoölogy, the middle Comparative Anatomy and Palæontology, and the lowest series the evolution of Embryology.

Very strikingly is it shown that not only the scientific side of all branches of biology, but also the philosophical or speculative side, has been developed during the old age of the tree, or during the last 300 years. In fact, modern zoölogy and inductive methods may be said to have begun with William Harvey in the seventeenth century.

It is true that when the tree began its life, men had ideas and conceptions of the principles underlying nature, but most of these were crude and inaccurate, based on mere hearsay or tradition, and differing but little from those held before the beginning of the Christian era.

The science of anatomy had been at a standstill since the time of Galen (A.D. 130). This brilliant anatomist, it is true,

advanced the study of anatomy by his careful dissections of apes and some of the lower animals, and he also wrote extensively on physiology; but accurate as some of his observations were, his errors, particularly in physiology, were many. His works, however, remained authoritative for fully 1400 years; his statements overruled the demonstrations of nature, and he was so reverenced that whoever had the courage to dispute him was liable to persecution and ostracism.

Physiology was not materially different from metaphysics, and both were affected with superstition. The ancient belief that the body contained *four humors*—"blood," "phlegm," "yellow bile," "black bile"—was held, and Galen had added to these a "pneuma," which pervaded the whole body, mingling with the humors and supporting life. The proper mixture of four elements—heat, cold, wetness and dryness—constituted the normal individual. The administration of drugs was in accordance with this belief. Systematic zoölogy did not exist. There was no true conception of species, no accurate description of animals, and no adequate system of classification. The naturalists were merely compilers and copyists of Aristotle and other ancient writers.

The philosophical or speculative in biology was retained by the clergy, almost the only persons really interested in the conservation of documents, and as a class the only ones able to read and write.

Some of the Greeks had had explanations of the succession of organisms on the globe. Aristotle believed that the first animals arose from the ocean, and that low forms of life were constantly springing into existence by spontaneous generation, a fallacy which was not completely rooted out of biology until the nineteenth century. Aristotle also perceived the principle of adaptation in nature, and considered the universe as the result of Intelligent Design. These ideas of the Greeks had a marked influence on Christian thought for many centuries. Augustine (fifth century) believed that a living substance had been made by the Creator, and that from this had developed all the diverse organisms of the present time. Two other famous churchmen advocated similar views, Erigena in the ninth century, and

FELLING THE TREE

4/2/23

Thomas Aquinas in the thirteenth, each the foremost scholar of his day. But naturally a wider and deeper knowledge of biological phenomena was necessary before philosophical biology could have a strong foundation. Hence the philosophy of zoölogy dates from the awakening of science in the seventeenth century.

From the time that the Big Tree was a mere seedling up to the time that it measured fully 13 feet in diameter, there was scarcely a single discovery in the field of natural science worthy of record. One event, however, which occurred when the tree measured only 12 inches in circumference is of some interest. Silk was one of the treasures obtained from the Far East. Its production was carried on solely by the Chinese, who jealously guarded the silkworms and their eggs. The story is that two monks travelling in China succeeded in smuggling some eggs out of the country by concealing them in a hollow cane, and brought them into Europe. In the warm climate of the south the eggs developed into strong healthy worms. From such a humble beginning arose the extensive silk industry of southern Europe.

The stagnation of the study of anatomy for more than a thousand years was due to an extravagant admiration of Galen, over-confidence in his writings, and the failure of men to make observations for themselves, or to believe what they saw with their own eyes. Vesalius (born in 1514) was the first anatomist to assert independence, and to him is due the credit of laying the foundations of modern anatomy. Vesalius dissected the human body and accurately described what he found. He established a school of anatomy at Padua, and among his students was Fabricius, the teacher of Harvey, who startled the world in 1619 with his discovery of the circulation of the blood. This discovery, which revolutionized the study of physiology, and gave new impetus to the study of anatomy, met with bitter opposition from the followers of Galen, but Harvey successfully defended himself.

The opposition to Harvey set men to thinking, and investigation began. All forms of life were studied with all available means. Harvey, from an investigation on the development of

the chick, laid the foundations of the study of embryology, one of the four great supports of the theory of evolution; and propounded the theory of *Epigenesis*, a theory vigorously argued by philosophers for many years. The compound microscope, already mentioned, was applied to the study of organisms by Leeuwenhoek and Malpighi. The former demonstrated capillary circulation (1690) and discovered red blood corpuscles, infusioria and spermatozoa (1677). These spermatozoa were regarded by some as parasites of animal bodies, by others as embryos which only needed nourishment to develop into an adult form. Malpighi applied the microscope to the study of the chick, and his observations led him to announce the theory of *Preformation*, which was opposed to the epigenesis of Harvey.

The preformationists contended that a given species contained within its sperm or ovum all the descendants of that species, with all organs and parts fully formed. In other words, embryos were only miniature adults, and were contained one within another like a series of Chinese boxes, in successive grades of size. The doctrine of epigenesis was that each sperm or ovum contained a *homogeneous* living substance which became differentiated by gradual changes into an individual resembling the parent. Preformation was supported by Spallanzani, Bonnet, Haller and even Cuvier. Its absurdity was shown by the work of Wolfe (1759), who firmly established the doctrine of epigenesis as it is believed to-day, although more frequently known as *embryological development.*

The stimulus given to research by Harvey's discovery, the intercourse and exchange of views among men, and the voyages to all parts of the world resulted in an accumulation of a great mass of facts, which were of little value unless classified. Conrad Gesner (in 1551–1558) had given a complete bibliography of zoölogy, and was the most important of the earlier naturalists. About a hundred years later Ray, an English zoölogist (1670), made an attempt to establish a "system of classification," but he had no true conception of species. It remained for Linnæus to complete a system which served its purpose so well that it has remained practically unchanged to the present time.

Linnæus recognized that certain groups of animals were subordinate to other groups, and by his *binomial nomenclature* he provided a place in his system for every species. To each species two Latin names were given; the first, always beginning with a capital, was the name of the genus; the second, now usually spelled with a small letter, that of the species. For example, the scientific name of our Big Tree is "*Sequoia gigantea*," that is, *Sequoia* is the name of the genus, and *gigantea* the name of the species. (To avoid confusion, it is customary now to add the name of the scientist who first describes the species; thus, "*Sequoia gigantea* Decaisne," indicates that Decaisne was the naturalist who first described and named the Big Tree.)

The first edition of Linnæus' "Systema Naturæ" was published in 1735. Linnæus was a firm believer in the special creation of each species, and in one of his books says, "We reckon as many species as issued in pairs from the hands of the Creator."

Among the naturalists of the eighteenth century, Goethe and Cuvier are conspicuous. The former (1796), although a great poet, made valuable contributions to science. He introduced the word "morphology" as a designation of the study of form or structure, and was the first to advance the *vertebral theory* of the skull, that is, that the skull represents modified vertebræ. He recognized the significance of vestigial organs, for example, gill slits in human embryos, appendages in whales, etc., and predicted the discovery of the premaxilla in man—the supposed absence of which was considered to be a character which distinguished man from the apes.

It was, however, Georges Cuvier (born in 1769), the famous French naturalist, who was the leader in science for more than half a century. He stands as a striking example of a man who was remarkably correct in his observations of nature, but equally incorrect in his generalizations. His work on the Tertiary mammals of France marked the beginning of palæontology. He was the first to point out the resemblance between "*Anchitherium*" and the modern horse, a fact which is one of the strongest evidences of evolution. He was a preformationist and believed in *Catastrophism* (the theory that the earth as it is at present is the

result of successive catastrophes), rather than *Uniformitarianism* (the belief that the present condition of the earth has been brought about by a gradual, uniform change). The work of Cuvier in comparative anatomy is also important, and he is called the founder of this science. He recognized the principle of correlated growth, and in "Le Régne Animal" improved the classification of animals.

The last century of our tree's life was remarkable for the discoveries in all branches of natural science. De Blainville (1839–1849) and Lyell (1797–1875) made valuable contributions to palæontology and geology. Lyell's "Principles of Geology" (1830–1833) dealt a death blow to catastrophism, and is a work second only in importance to the "Origin of Species."

Milne-Edwards (1800–1818) enunciated the principle of the physiological division of labor.

Von Baer (1828) announced the law that bears his name, namely, "individual development is a recapitulation of race development."

Schleiden and Schwann (1838–1839) discovered cells in plants and animals, and propounded the cell theory.

Valentin (1839) named the "nucleus," and was the first to speak of the "cell theory."

Purkinje and von Mohl (1840) named the substance of the cell *protoplasm*.

Serres (1842) asserted that all missing links would be found in embryology.

De Barry (1843) observed the union of sperm and ovum.

Kölliker (1846) demonstrated that sperm are developed from the tissues of the testes.

Owen (1846) pointed out the difference between *homologous organs*, for example, the arm of man, fore limb of horse, and wing of bird, organs which are formed on the same structural plan, and *analogous* organs, for example, wing of bird and wing of butterfly, organs differing entirely in structure, but performing the same function.

Remak (1850) described "three germinal layers," and Huxley (1859) homologizes them in the lower animals.

THE SECTION BEFORE SHIPMENT

Rapid strides were made also in systematic zoölogy and in zoö-geography. The relations of the lower animals were worked out by Leuchart, Vaughn Thompson, Dujardin, Agassiz and a host of others.

Expeditions were sent out to explore the earth and the sea. Famous among these are the voyage of the "Beagle," on which Darwin served and did some of his earliest biological work; and the voyage of the "Rattlesnake," on which Huxley was Assistant Surgeon.

In 1859 Darwin published his "Origin of Species," a book which is universally admitted to have had more influence on human thought than any other work of the century.

Darwin's theory of the "Origin of Species" may be stated briefly as follows: All species tend to vary. No two individuals of the offspring of a pair are exactly alike. On account of this variation in structure or function, certain individuals are better able to thrive than their fellows. These animals transmit these characters to their offspring, which in turn survive in the struggle with their fellows. Thus nature eliminates those variations which are disadvantageous to the organism, each individual being tested in its struggle to maintain its existence. The accumulation of these favorable variations through many generations is supposed to produce an organism quite different from the original stock, or, in other words, a new form.

Few works have been constructed with more care and skill. For twenty years Darwin collected facts from all available sources, and made innumerable observations himself. The evidence in support of his theory was drawn from all branches of natural science: comparative anatomy, embryology, palæontology and zoö-geography. So numerous were the facts that he presented, and so careful was the exposition of his theory, that in less than twenty years it became the working hypothesis of nearly every biologist.

Long before Darwin's time the resemblance between groups of animals had been recognized, and many new facts made known by investigators from Vesalius onward emphasized these resemblances. In 1620 Bacon published "Novum Organum," in which

he advocated the unity of nature. Descartes (born, 1596) attempted to explain the universe on natural laws. Leibnitz (born, 1646) advanced a theory of the continuity of organisms. The term "*evolution*" was introduced by Bonnet as a name of the process by which organisms had become differentiated. He expressed this relationship by introducing the idea of a "scale of beings," which formed the links of a chain. This conception has persisted up to the present time, in the expression "the missing link."

It was Lamarck (1809), the contemporary and fellow-countryman of Cuvier, who was the first to express the blood-relationship of organisms, as is done to-day, namely, by means of the *genealogical tree*. This eminent anatomist and investigator held views much in advance of his time. He rejected entirely the fixity of species, and believed that all animals now existing had been derived from a common stock by a process of gradual change. In one place he affirms that "Nature needs only matter, time and space to produce all changes." The two factors which he believed most important in producing these modifications were the reaction of the organisms to their environment and the inheritance of the modifications resulting from this reaction and of the effects of use and disuse of organs.

Lamarck's theory was partially smothered in the ridicule which Cuvier heaped upon it. Cuvier was a firm believer in the immutability of species and his great authority in biological subjects made him a powerful dictator of public opinion.

From Lamarck to Darwin there were few philosophers of note. Erasmus Darwin (1794) and Oken (1805) embodied in their writings the idea of the continuity of life.

In 1844 a book called "Vestiges of Creation" appeared and caused quite a sensation. That this was published anonymously is significant of the attitude of the public toward the idea of evolution.

Naturally the "Origin" met with a storm of opposition, but it was vigorously defended by Huxley. He it was who perhaps more than any other scientist secured for the "Origin of Species" a fair and impartial treatment and thus aided the cause of truth.

THE STUMP OF "MARK TWAIN"
Ninety feet in circumference

Among the earlier champions of Darwin's theory, were Lyell, Tyndall, Hooker and Spencer.

More recently the philosophy of zoölogy has centered around the question of the inheritance of characters acquired during the life of the organism, and biologists at present are divided into two schools; one, nominally led by Herbert Spencer, contend that such characters are inherited; the other, of which August Weismann is the head, deny the inheritance of acquired characters and affirm that "natural selection," acting on congenital variations, is sufficient to produce the diverse organic forms.

Since Darwin's time the growth of biology has been phenomenal. This is due to the enthusiasm of the great number of investigators in every branch of science, and to the application of modern inventions in methods of research. Governments, as well as private individuals, have contributed generously to aid the work. Expeditions for exploring the depths of the sea and the remotest parts of the world have been organized and successfully carried out.

A. R. Wallace in 1876 published his "Distribution of Animals," which was the first complete treatise on zoö-geography, one of the pillars of evolution.

The "Challenger" expedition (1872–1876), sent out by England, obtained more than 8000 species new to science.

The United States Fish Commission, established by the Government, through the energy of Professor S. F. Baird, as well as the National Museum and the Geological Survey, have made valuable contributions to science.

Among the seashore laboratories, that founded at Naples in 1870, by Professor Dohrn, is most famous.

Palæontology too has had a rapid growth. Cope in this country discovered and described more than a thousand new species of vertebrates, many of which are on exhibition in the Hall of Fossil Vertebrates. In invertebrate palæontology James Hall was one of the leaders, and a large proportion of the material upon which he did his monumental work is displayed in the Geological Hall.

The researches of Louis Pasteur have revolutionized both the

theory and practice of medicine, and bacteriological discoveries of the past decade have probably done more to alleviate human suffering than all the efforts of any previous century.

In short, every sphere of human activity, social, religious, industrial and intellectual, has felt the influence of and has been profoundly modified by those marvelous discoveries of science which have occurred even since this Sequoia attained gigantic proportions.

THE AMERICAN MUSEUM JOURNAL.

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AMERICAN MUSEUM OF NATURAL HISTORY

The Evolution of the Horse

BY

William D. Matthew, Ph.D.

Associate Curator of Vertebrate Palæontology

SUPPLEMENT TO AMERICAN MUSEUM JOURNAL

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Guide Leaflet No. 9

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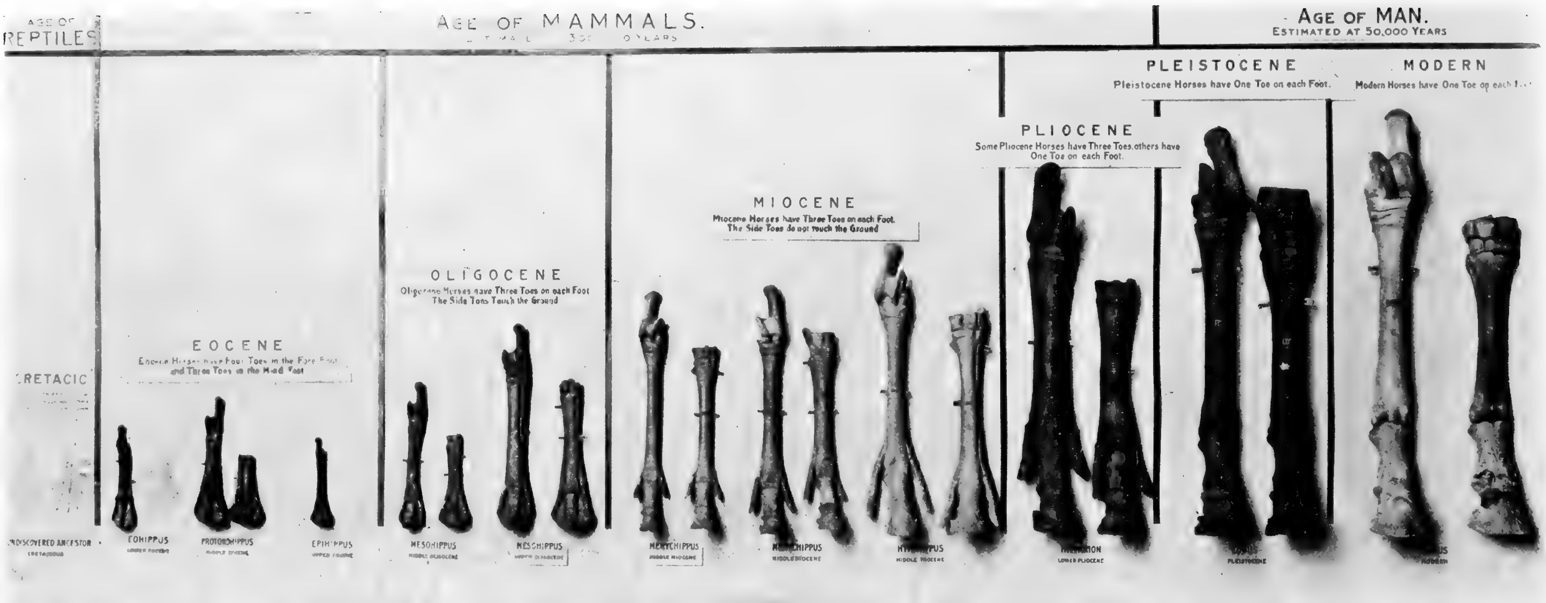


EVOLUTION OF THE HORSE. FEET
Series on exhibition in the American Museum

ILLUSTRATIONS OF EVOLUTION AMONG FOSSIL MAMMALS.

A.— The Horse.

By W. D. Matthew, Ph.D.,

Associate Curator, Department of Vertebrate Palæontology.

As a domestic animal the Horse is to be found almost everywhere that man can live. He is spread all over the world — from torrid to arctic climates, in all the continents, in remote oceanic islands — he is completely cosmopolitan. But as a wild animal the Horse is at present limited to the Old World, and is found there only in the open arid or desert plains of Central Asia and Africa. There are two species in Asia, the Asiatic Wild Ass (*Equus hemionus*), and the little known Przewalsky's Horse (*E. przewalskii*), while in Africa there are the African Wild Ass (*E. asinus*) and the several species of Zebra (*E. zebra, E. burchelli, E. quagga*). In the Americas and Australia there are no true wild horses, the mustangs and broncos of the Western Plains and South America being *feral* (domesticated animals run wild) and descended from the horses brought over from Europe by the early white settlers. When the Spaniards first explored the New World they found no horses on either continent. The Indians were quite unfamiliar with them and at first regarded the strange animal which the newcomers rode with wonder and terror, like that of the ancient Romans when Pyrrhus and his Greeks brought elephants—"the huge earth-shaking beast"[1] —to fight against them.

The Horse is distinguished from all other animals now living by the fact that he has but one toe on each foot. Comparison with other animals shows that this toe is the third or middle digit of the foot. The hoof corresponds to the nail of a man or the claw of a dog or cat, and is broadened out to afford a firm, strong support on which the whole weight of the animal rests. Behind the "cannon-bone" of the foot are two slender little

[1] Macaulay —"The Battle of Lake Regillus."

bones, one on each side, called *splint-bones*. These represent the second and fourth digits of other animals, but they do not show on the surface, and there is nothing like a separate toe. So that the horse may be said to be an animal that walks on its middle finger-nail, all the other fingers having disappeared.

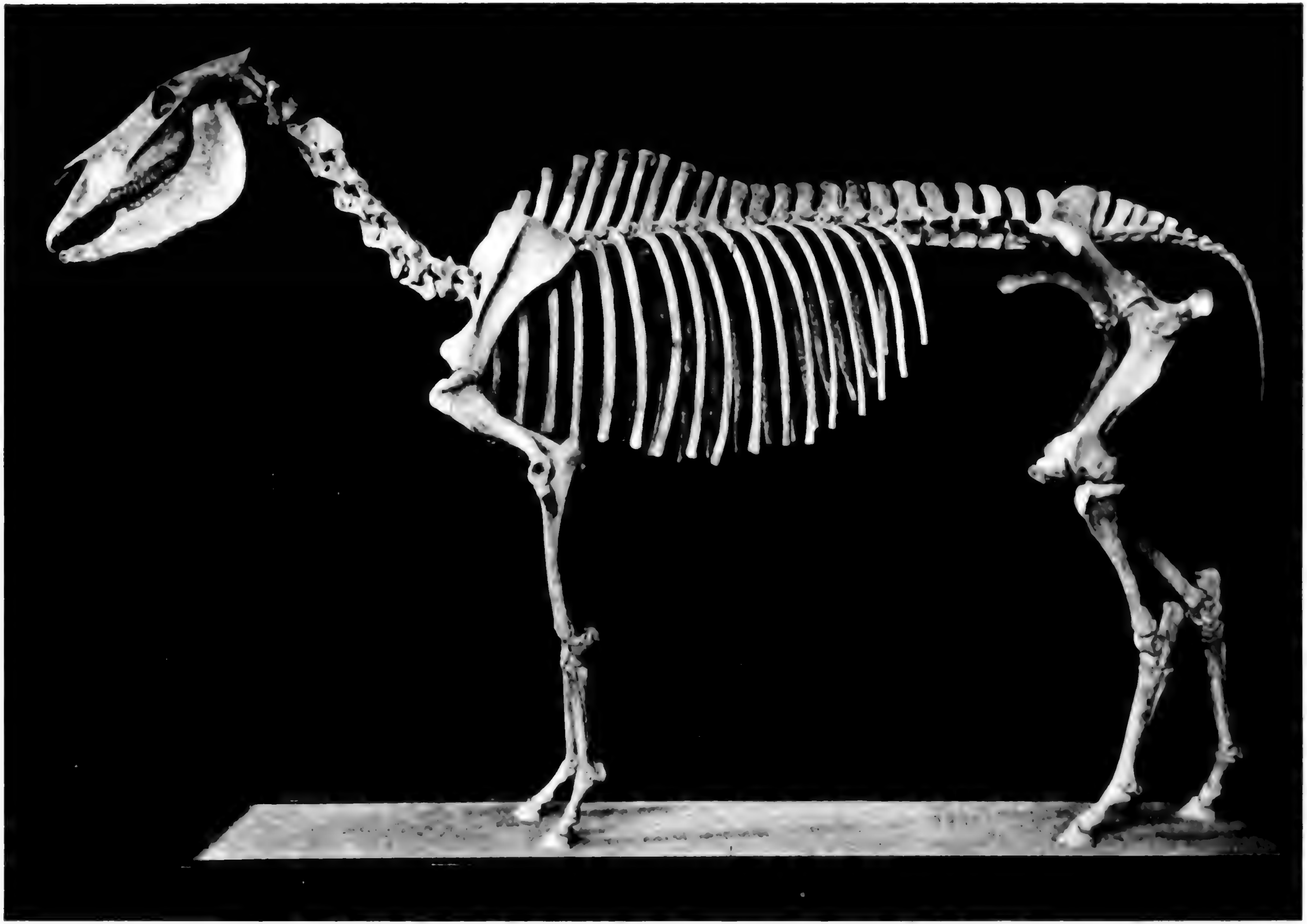
The teeth of the horse are almost equally peculiar. The molars are long, square prisms which grow up from the gums as fast as they wear off on the crowns. Their grinding surface exhibits a peculiar and complicated pattern of edges of hard enamel between which are softer spaces composed of dentine and of a material called "cement," much like the dentine in quality but formed in a different way. The dentine is formed on the inside surfaces of the enamel while the tooth is still within the jaw-bone; the cement is deposited on the outside surfaces of the enamel after the tooth has broken through the jaw-bone and before it appears above the gums.

Various other peculiarities distinguish the Horse from most other animals; some of these are shared by other hoofed animals. The two long bones of the fore-arm (*radius* and *ulna*) are separate in the greater number of animals, but in the Horse, and in many other hoofed animals they are consolidated into a single bone. The same consolidation is seen in the bones of the lower leg (*tibia* and *fibula*). The lengthening of the foot and stepping on the end of the toe raises the heel in the Horse, as in many other animals, to a considerable height above the ground, where it forms the hock joint, bending backward, as the knee bends forward. In these as in various other ways the legs of the horse are especially fitted for swift running over hard and level ground, just as its teeth are for grinding the wiry grasses which grow on the open plain.

The Zebra and the Ass have the same peculiar structure of teeth and feet as the Domestic Horse, and differ only in the color of the skin, proportions of various parts of the body etc.

Fossil Horses of the Age of Man.

The Age of Man, or Quaternary Period, is the last and by far the shortest of the great divisions of geological time. It includes the Great Ice Age or Glacial epoch (Pleistocene), when heavy



SKELETON OF "EQUUS SCOTTI," FROM THE LOWER PLEISTOCENE OF TEXAS
Mounted in the American Museum

continental glaciers covered the northern parts of Europe and North America, and the Recent Epoch, of more moderate climate during which civilization has arisen.

In the early part of the Quaternary Period, wild species of Horse were to be found on every continent except Australia. Remains of these true native horses have been found buried in strata of this age in all parts of the United States, in Alaska, in Mexico, in Ecuador, Brazil and Argentina, as well as in Europe, Asia and Africa. All these horses were much like the living species and most of them are included in the genus *Equus*. A complete skeleton of one of them (*Equus scotti*) found by the American Museum expedition of 1899 in Northern Texas, is mounted in the large wall-case. The difference between it and the Domestic Horse (see framed diagram of modern horse skeleton) is chiefly in proportions, the skull shorter with deeper jaws, the legs rather short and feet small in proportion to the body. In these characters this fossil horse resembles an overgrown zebra rather than a domestic horse. We know nothing of its coloring. It may have been striped, and in this case would have been very zebra-like; but there are some reasons for believing that it was not prominently striped. The bones are petrified, brittle and heavy, the animal matter of the bone having entirely disappeared and having been partly replaced by mineral matter. They are not much changed in color, however, and are so perfectly preserved that they look almost like recent bone.

All the remains of these native horses which have been found in America have been petrified more or less completely; this means that they have been buried for many thousands of years, for petrifaction is an exceedingly slow process.[1] It serves as an easy method of distinguishing them from bones of the Domestic Horse, found buried in the earth. These cannot in any case have been buried for more than four or five centuries, and have not had time to petrify.

Remains of these fossil horses from various parts of the United States are shown in the counter-case. One very rich

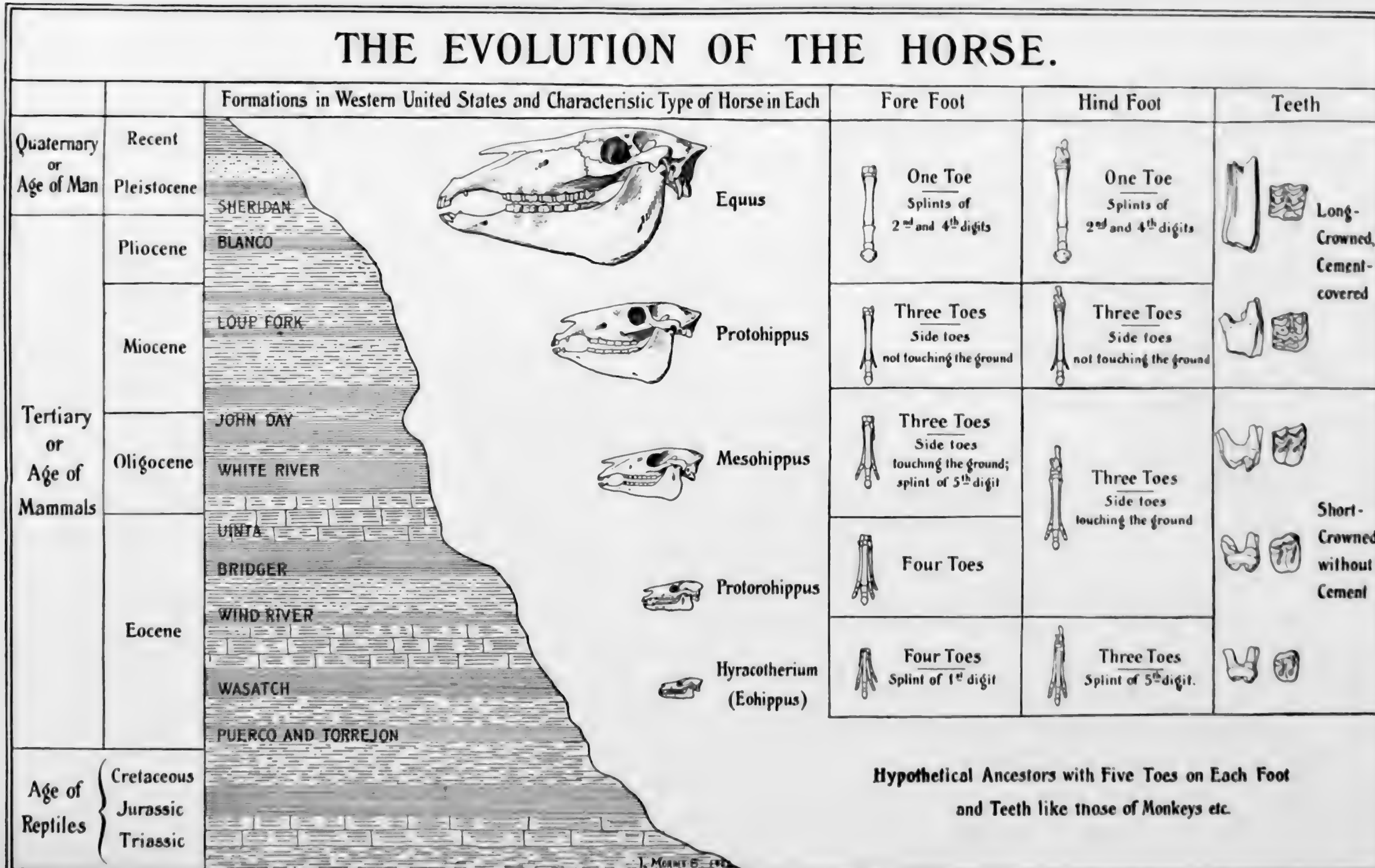
[1] The so-called petrifaction which occurs in some hot springs, coating objects dipped into them with a white, stony coat of lime is not true petrifaction. In true petrifaction the substance of the bone is replaced particle by particle with mineral matter.

locality is on the Niobrara river in Nebraska, another in central Oregon. Many separate teeth and bones have been found in the phosphate mines near Charlestown, S. C.; other specimens have come from central Florida, from southern Texas, Arizona, Kansas, Louisiana and even from Alaska. They are, in fact, so often found in deposits of rivers and lakes of the latest geological epoch (the Pleistocene) that the formation in the western United States has received the name of Equus Beds.

In South America, in strata of the Pleistocene Epoch, there occurs, besides several extinct species of the genus *Equus*, the *Hippidium*, a peculiar kind of Horse characterized by very short legs and feet, and some peculiarities about the muzzle and the grinding teeth. The legs were hardly as long as those of a cow, while the head was as large as that of a racehorse or other small breed of the Domestic Horse.

All these horses became extinct, both in North and South America. Why, we do not know. It may have been that they were unable to stand the cold of the winters, probably longer continued and much more severe during the Ice Age than now. It is very probable that man — the early tribes of prehistoric hunters — played a large part in extinguishing the race. The competition with the bison and the antelope, which had recently migrated to America — may have made it more difficult than formerly for the American Horse to get a living. Or, finally, some unknown disease or prolonged season of drought may have exterminated the race. Whatever the cause, the Horse had disappeared from the New World when the white man invaded it (unless a few individuals still lingered on the remote plains of South America), and in his place the bison had come and spread over the prairies of the North.

In Central Asia, two wild races persist to the present day; others were domesticated by man in the earliest times, and their use in Chaldæa and Egypt for draught and riding is depicted in the ancient mural paintings. In Africa the larger species became extinct in prehistoric times, as in America, but the smaller zebras still survive in the southern part of the continent (one species, the Quagga, abundant fifty years ago, is now probably extinct), and the African Wild Ass is found in the fauna of the northern


THE EVOLUTION OF THE HORSE.
Formations in Western United States and Characteristic Type of Horse in Each
Fore Foot
Hind Foot
Teeth
Quaternary or Age of Man
Recent
Pleistocene
Pliocene
Miocene
Oligocene
Eocene
Tertiary or Age of Mammals
Age of Reptiles
Cretaceous
Jurassic
Triassic
SHERIDAN
BLANCO
LOUP FORK
JOHN DAY
WHITE RIVER
UINTA
BRIDGER
WIND RIVER
WASATCH
PUERCO AND TORREJON
Equus
Protohippus
Mesohippus
Protorohippus
Hyracotherium (Eohippus)
One Toe
Splints of 2nd and 4th digits
Three Toes
Side toes not touching the ground
Three Toes
Side toes touching the ground; splint of 5th digit
Four Toes
Four Toes
Splint of 1st digit
One Toe
Splints of 2nd and 4th digits
Three Toes
Side toes not touching the ground
Three Toes
Side toes touching the ground
Three Toes
Splint of 5th digit.
Long-Crowned, Cement-covered
Short-Crowned, without Cement
Hypothetical Ancestors with Five Toes on Each Foot and Teeth like those of Monkeys etc.

part. The Wild Horse of prehistoric Europe, a small race, short-legged and shaggy-haired, was domesticated by man, a fact that is known from the rude drawings scratched on bone or ivory by men of the Neolithic or Polished Stone Age. But the Domestic Horse now in use is derived chiefly from the Asiatic race, although it is probable that in some breeds there is a considerable strain of this shaggy, short-legged European race, and it is possible also that African races may have been domesticated and to some extent mixed with the Asiatic species. The domesticated Ass is a descendant of the African species.

The Evolution of the Horse.

The history of the evolution of the Horse through the Tertiary period or Age of Mammals affords the best known illustration in existence of the doctrine of evolution by means of natural selection and the adaptation of a race of animals to its environment. The ancestry of this family has been traced back to nearly the beginning of the Tertiary without a single important break. During this long period of time, estimated at nearly three millions of years, these animals passed through important changes in all parts of the body, but especially in the teeth and feet, adapting them more and more perfectly to their particular environment, namely the open plains of a great plateau region with their scanty stunted herbage, which is the natural habitat of the Horse.

In the series of ancestors of the Horse we can trace every step in the evolution of those marked peculiarities of teeth and feet which distinguish the modern Horse from an ancestor which so little suggests a horse that, when its remains were first found forty years ago, the animal was named by the great palæontologist Richard Owen, the *Hyracotherium* or "Coney-like Beast." Its relation to the Horse was not at that time suspected by Professor Owen, and was recognized by scientific men only when several of the intermediate stages between it and its modern descendant had been discovered. On the other hand this first ancestor of the Horse line is very difficult to distinguish from the contemporary ancestors of tapirs and rhinoceroses, and indicates how all the

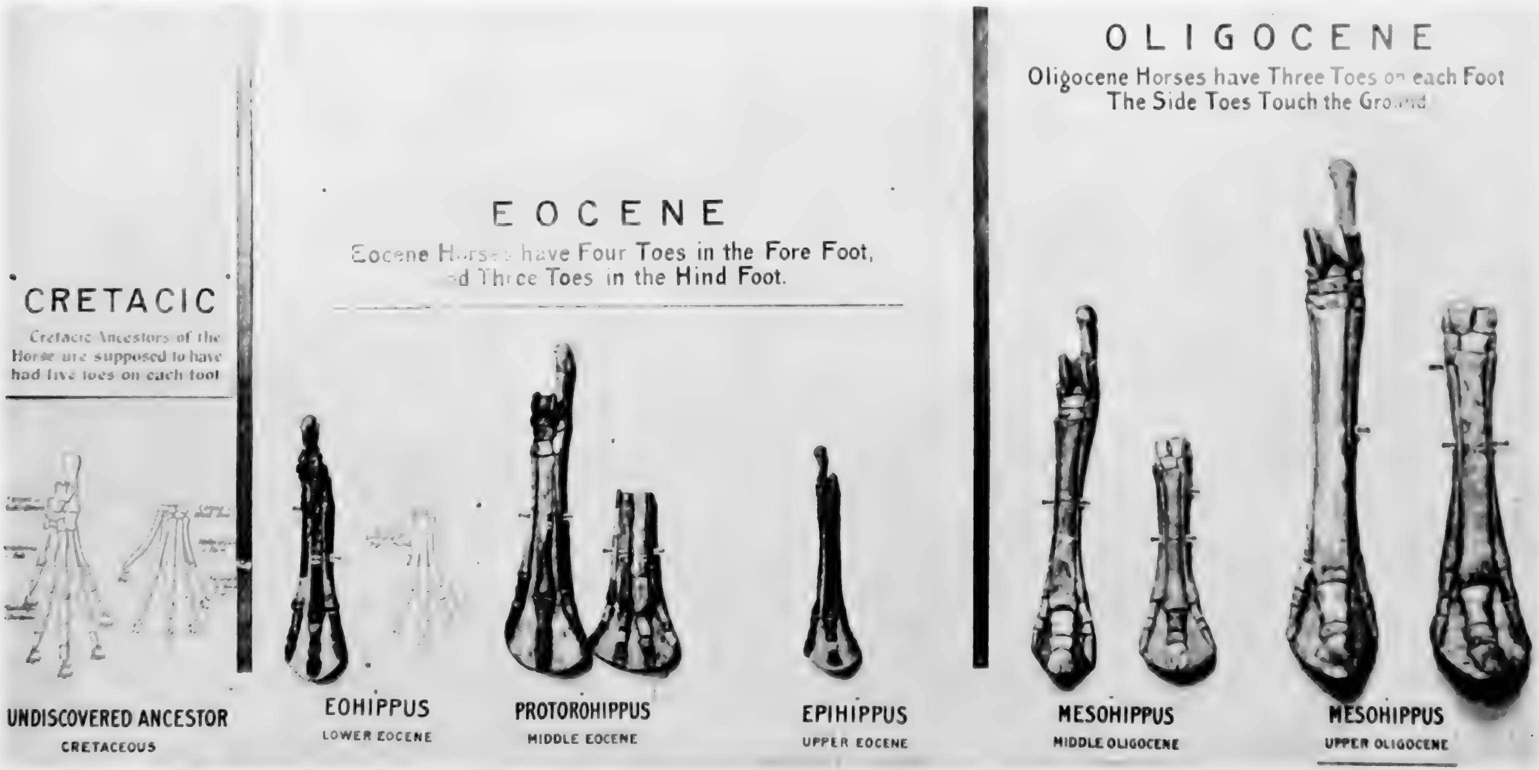
modern quadrupeds have diverged from a single type, each becoming adapted to the needs of its especial mode of life.

The earliest known ancestors of the Horse were small animals not larger than the domestic cat, with four complete toes on each forefoot and three on each hindfoot. There is reason to believe that the still more ancient ancestors of this and all other mammals had five toes on each foot. In the forefoot of the earliest known stage we find a splint-bone or small, slender rudiment representing the missing first digit or thumb, which no longer appears on the surface of the foot, while in the hindfoot there is a similar rudiment representing the outer or fifth digit, but no trace is left of the innermost or first digit. The proportions of the skull, the short neck and arched back and the limbs of moderate length, were very little horse-like; recalling, on the contrary, some modern carnivorous animals, especially the civets (*Viverridæ*). The teeth were short-crowned and covered with low rounded knobs of enamel, suggesting those of monkeys and of pigs or other omnivorous animals, but not at all like the long-crowned complicated grinders of the Horse.

Commencing with the *Hyracotherium*, twelve stages have been recognized from as many successive formations, showing the gradual evolution of the race into its modern form, and each stage is characteristic of its particular geological horizon. Some of the stages have been found in several parts of the world, but by far the most complete and best known series comes from the Tertiary Badlands of the Western States. Besides the main line of descent which led into the modern horses, asses and zebras, there were several collateral branches which have left no descendants. Of some stages all parts of the skeleton have been found; of others only the jaws, or jaws and feet, are known. We can mention only the more important stages.

1 and 2.[1] **Hyracotherium** and **Eohippus.** LOWER EOCENE. The *Hyracotherium* is the most primitive stage known, but only the skull has been found, so that it has not been determined exactly what the feet were like. The teeth display six rounded knobs or cusps on the upper molars and four on the lower ones,

[1] These numbers refer to the stages in the direct line of descent of the modern Horse; see frontispiece.



EARLY STAGES IN THE EVOLUTION OF THE FEET
From the series on exhibition in the American Museum

and these are just beginning to show signs of fusing into cross-crests. The premolar teeth have only one main cusp, except the third and fourth premolars (next the molars) in each jaw, which have two and three, respectively. The only specimens which have been found were in the London Clay or Lower Eocene of England and are preserved in the British Museum.

The *Eohippus* is much better known. It comes from the Lower Eocene of Wyoming and New Mexico, and is very like the *Hy-*

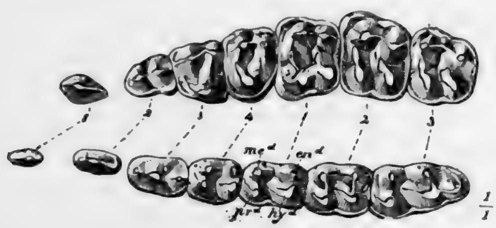


FIG. 1.—UPPER AND LOWER TEETH OF "EOHIPPUS," FROM THE LOWER EOCENE OF WYOMING. NATURAL SIZE

racotherium except that the molar teeth have the cusps more clearly fusing into cross-crests, and the last premolar is beginning to look like one of the true molars. The forefoot of this animal has four complete toes and the splint of a fifth. The hindfoot has three complete toes and the splint of another. A specimen of the hindfoot is shown in the series in the A-case and many incomplete specimens, skulls, jaws etc., of several species in the counter-case.

3 and 4. **Protorohippus** and **Orohippus.** MIDDLE EOCENE. In these animals the splint of the first digit in the forefoot and the splint of the fifth digit of the hindfoot have disappeared, but there are still four complete toes in the fore- and three in the hind-foot. The crests on the molars are a little clearer and the last premolar has become almost like the molars, while the next to the last premolar is beginning to become so. A skeleton of *Protorohippus* is mounted in the wall-case. It shows an animal of the size of a small dog, and proportioned much like the breed known as the *whippet*, of which a skeleton has been placed near by for comparison with the *Protorohippus* skeleton. The *Protorohippus* was found by Dr. J. L. Wortman in 1880 in the Wind

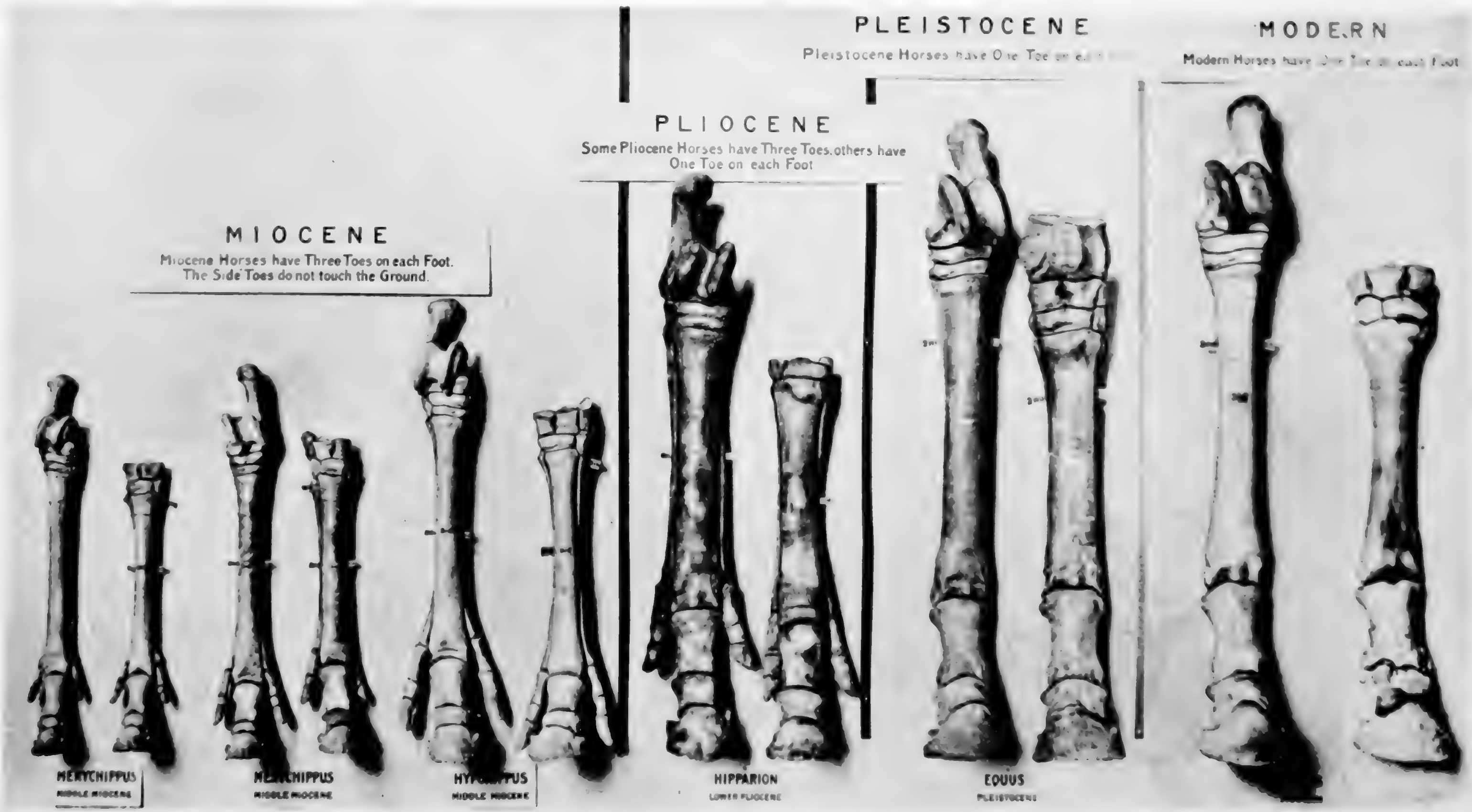
River Badlands of Wyoming, and was described by Professor Cope and others under the name of the "Four-Toed Horse."

Of *Orohippus* we have only parts of jaws and teeth. A specimen of the forefoot is exhibited in the Museum of Yale University.

5. **Epihippus.** Upper Eocene. Of this stage of the evolution of the Horse only incomplete specimens have been found. The molar teeth have the once round cusps almost completely converted into crescents and crests, while another tooth of the premolar series has become like the molars. The toes are still four in the forefoot and three in the hindfoot, but the central toe in each foot is becoming much larger than the side toes, a feature which may be seen in the hindfoot shown in the series in the case. (This species happens to be somewhat smaller than those found in the Middle Eocene stage, but no doubt there were others of larger size living at the same time.)

Palæotherium and *Paloplotherium* of the Upper Eocene of Europe form a side branch of the Horse line. They were very abundant in Europe, but have not been found in the New World. On each foot they had three toes of nearly equal size, and the teeth show a rather peculiar pattern. One of these animals was thought by Professor Huxley to be a direct ancestor of the Horse, but it now is considered to be merely a collateral relative. Some species of *Palæotherium* were of large size, equal to a tapir. They were first described in the year 1804 by the celebrated Baron Cuvier from remains found in the gypsum quarries of Montmartre, Paris. A large series of skulls, jaws, foot-bones etc., from the Upper Eocene of France, is exhibited in one of the counter-cases.

6 and 7. **Mesohippus.** Oligocene (*White River Formation*). In this stage there are three toes on each foot, a splint representing the fifth digit of the forefoot of the Eocene ancestors. The middle toe is now much larger than the side toes, which bear very little of the weight of the animal. Three of the premolars have now become entirely like the molar teeth, the crests on the crown are completely formed, and the outside crest in the upper molars has taken the shape of two crescents. In the Middle Oligocene is found *Mesohippus bairdi* about the size of a coyote,



LATER STAGES IN THE EVOLUTION OF THE FEET
From the series on exhibition in the American Museum

while in the Upper Oligocene occurs *Mesohippus intermedius* as large as a sheep. Of both these animals all parts of the skeleton are known, and a good series of skulls, feet, jaws, palates etc. is

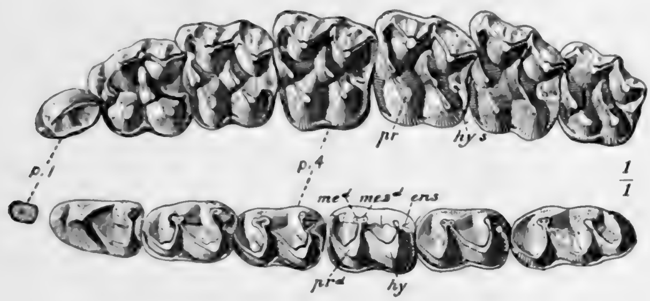


FIG. 2.—UPPER AND LOWER TEETH OF "MESOHIPPUS BAIRDI," FROM THE MIDDLE OLIGOCENE OF SOUTH DAKOTA. NATURAL SIZE

exhibited in the counter-case, besides the specimens shown in the series of feet and in the series of skulls.

8. **Anchitherium.** LOWER MIOCENE. This stage has been found both in Europe and in America. It is much like its predecessor, but is larger and has the crests of the teeth somewhat higher and more complete. It probably is not in the direct line of descent of the horses, but is on a side branch. A palate, jaws, teeth and foot-bones are exhibited here.

9. **Parahippus** and **Hypohippus.** MIDDLE MIOCENE. In *Parahippus* the tooth-crests are much higher, and the transverse ridges on the upper molars are beginning to change shape so as to become a second pair of crescents inside the outer pair. *Hypohippus* is off the direct line of descent; its teeth are like those of *Anchitherium*, by which name it has been generally called, but the animal was much larger, equalling a Shetland pony in size. A complete skeleton of the *Hypohippus* is shown in wall-case 15, and illustrates very well the general characters of the Three-Toed Horses, although it is not in the direct line. This specimen was found near Pawnee Buttes, Colorado, in 1901 by Barnum Brown, of the Whitney expedition. Other incomplete specimens of *Hypohippus*, *Parahippus* and *Merychippus* are shown in the counter-case, and casts of the feet and skull in the evolution series in A-Case 49. It may be observed that in the forefoot of

Hypohippus small rudiments still remain representing the first and fifth digits, but there is no splint of the fifth, as in *Mesohippus*. The second and fourth digits still touch the ground, though lightly.

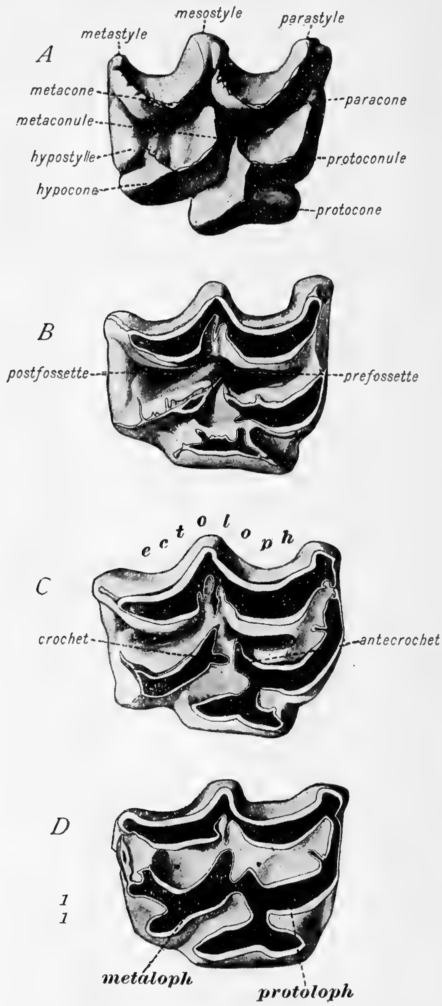


FIG. 3.—UPPER MOLAR OF MODERN HORSE, SHOWING EARLY STAGES OF WEAR OF THE TOOTH. CROWN VIEW. NATURAL SIZE

The feet of *Parahippus* were much like those of *Hypohippus*, but the side toes were smaller.

10 and 11. **Protohippus** and **Pliohippus.** MIDDLE and

THREE-TOED HORSE "HYPOHIPPUS," FROM THE MIDDLE MIOCENE OF COLORADO
Rear view of skeleton, showing small side toes

UPPER MIOCENE. In this stage the crowns of the upper molars have become much longer, the two pairs of crescents on the upper molars are complete, with two half-separated cusps within the inner pair. And the valleys between the crests have become filled with cement, so that with the wear of the teeth the edges of hard enamel are backed inside by dentine and outside by cement. In this way the surface of the tooth has a series of enamel ridges always projecting a little above the grinding surface, because the softer material on each side wears down into hollows, yet never breaking off, because they are braced so thoroughly on each side. This is a very efficient instrument for grinding hard grasses. In *Protohippus* and *Pliohippus*, especially in the former, the crowns of the teeth are by no means as long as in the modern horses; they must therefore wear more slowly or wear out at an earlier age.

The feet in these two genera have but one toe touching the ground. The side toes (second and fourth digits) are complete, but much more slender than in the earlier stages and are apparently useless, as they cannot reach the ground. In some species of *Pliohippus* they have almost disappeared. The fore-foot of *Protohippus* still retains tiny nodules of bone at the back of the "wrist" (sometimes improperly called in the Horse the "knee-joint"), which are the remains of the first and fifth digits.

Hipparion. PLIOCENE. This genus, probably also a side branch of the genealogical tree of the horse family, is much like *Protohippus*, but larger and with more complication about the tooth pattern. It is common in the European Pliocene beds and has been found in America also. The feet are still three-toed, the side toes as large as those of the older *Protohippus*.

12. **Equus.** PLEISTOCENE and RECENT. In this stage, that of the modern Horse, the side toes have entirely disappeared and are represented by splints on the fore- and hind-foot. No trace remains on the forefoot of the little nodules which in *Protohippus* represented the first and fifth digits. The crowns of the teeth are much longer than in the last stage, and of the two half-separated inner columns on the upper molars, one has disappeared, the other has increased in size and changed in form. The skull has lengthened and the animal is much larger.

Hippidium. Pleistocene. South America. The feet are like those of *Equus*, except that they were short and stout. The teeth are like those of *Pliohippus*, from which it is supposed to be descended. The skull is large and long with very long slender nasal bones. Casts of the skull and limbs presented by the Museo Nacional of Buenos Ayres, Argentine Republic, are exhibited here.

Meaning of the Change in Feet and Teeth.

Along with the disappearance of the side toes in the evolution of the Horse there is a considerable increase in the proportionate length of the limbs, and especially of the lower part of the leg and foot. The surfaces of the joints, at first more or less of the ball-and-socket kind, which allows free motion of the limb in all directions, become keeled and grooved like a pulley-wheel, permitting free motion forward and backward, but limiting the motion in all other directions and increasing considerably the strength of the joint. By this means the foot is made more efficient for locomotion over a smooth regular surface, but less so for traveling over very rough ground, and it becomes of little use for striking or grasping or the varied purposes for which the feet of polydactyl animals are used.

The increased length in the lower leg and foot increases the length of the stride without decreasing its quickness. The heavy muscles of the leg are chiefly in the upper part, and to increase the length of the lower part changes the centre of gravity of the limb very little. Consequently the leg swings to and fro from the socket nearly as fast as before, since in an ordinary step the action of the leg is like that of a pendulum and the speed of the swing is regulated by the distance of the centre of gravity from the point of attachment, as that of a pendulum is by the height of the bob. To increase the length of lower leg and foot therefore gives the animal greater speed; but it puts an increased strain on the ankles and toe-joints, and these must be strengthened correspondingly by converting them from ball-and-socket joints to "ginglymoid" or pulley joints. Additional strength, likewise at the expense of flexibility, is obtained by the consolidation of the two bones of the fore-arm (*ulna* and

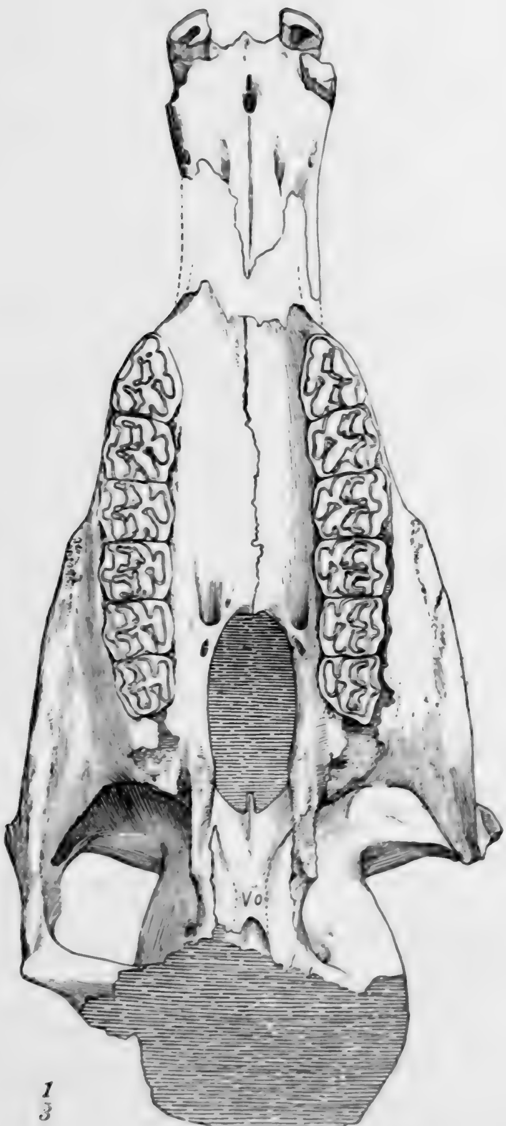


FIG. 4.—PALATE AND UPPER TEETH OF "EQUUS INTERMEDIUS," FROM THE LOWER PLEISTOCENE OF TEXAS. ONE-THIRD NATURAL SIZE

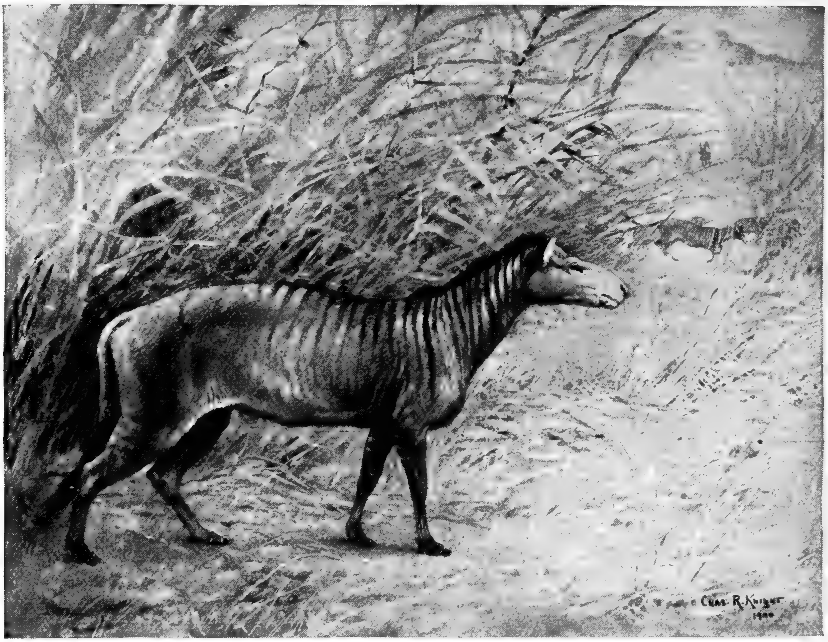
radius) and of the leg (*tibia* and *fibula*) into one, the shaft of the smaller bone practically disappearing, while its ends become fused solidly to its larger neighbor.

The increase in length of limb renders it necessary for the grazing animal that the head and neck should increase in length in order to enable the mouth to reach the ground. An example of these changes is the modern Horse, in which we find the neck and head much elongated when compared with the little *Hyracotherium* and this elongation has taken place *pari passu* with the elongation of the legs. The reduction and disappearance of the side toes and the concentration of the step on the single central toe serve likewise to increase the speed over smooth ground. The soft yielding surface of the polydactyl foot is able to accommodate itself to a rough irregular surface, but on smooth ground the yielding step entails a certain loss of speed. A somewhat similar case is seen in the pneumatic tire of a bicycle; a "soft" tire accommodates itself to a rough road and makes easier riding, but a "hard" tire is faster, especially on a smooth road. Similarly, the hard, firm step from the single toe allows of more speed over a smooth surface, although it compels the animal to pick its way slowly and with care on rough, irregular ground.

The change in the character of the teeth from "brachydont" or short-crowned to "hypsodont" or long-crowned enables the animal to subsist on the hard, comparatively innutritious grasses of the dry plains, which require much more thorough mastication before they can be of any use as food than do the softer green foods of the swamps and forests.

All these changes in the evolution of the Horse are adaptations to a life in a region of the level, smooth and open grassy plains which are now its natural habitat. At first the race was better fitted for a forest life, but it has become more and more completely adapted to live and compete with its enemies or rivals under the conditions which prevail in the high dry plains of the interior of the great continents. The great increase in size, which has occurred in almost all races of animals whose evolution we can trace, is dependent on abundance of food. A large animal, as may be shown on ordinary principles of mechanics, requires more food in proportion to its size than does a

small one, in order to keep up a proper amount of activity. On the other hand a large animal is better able than a small one to defend itself against its enemies and rivals. Consequently, as long as food is abundant, the larger animals have the advantage over their smaller brethren, and by the laws of natural selection the race tends to become continually larger until a limit is reached, when sufficient food becomes difficult to obtain, the



RESTORATION OF THE FOUR-TOED HORSE
Oldest known Ancestor of the Modern Horse; only 16 inches high
Photo from original watercolor by C. R. Knight, based on mounted skeleton in American Museum

animal being compelled to devote nearly all its time to getting enough to eat.

Cause of the Evolution.

The evolution of the Horse, adapting it to live on the dry plains, probably went hand in hand with the evolution of the plains themselves. At the commencement of the Age of Mam-

mals the western part of the North American continent was by no means as high above sea-level as now. Great parts of it had but recently emerged and the Gulf of Mexico still stretched far up the valley of the Mississippi. The climate at that time was probably very moist, warm and tropical, as is shown by the tropical forest trees, found fossil even as far as Greenland. Such a climate, with the low elevation of the land, would favor the growth of dense forests all over the country, and to such conditions of life the animals of the beginning of the mammalian period must have been adapted. During the Tertiary the continent was steadily rising above the ocean-level, and at the same time other influences were at work to make the climate continually colder and drier. The coming on of a cold, dry climate restricted and thinned the forests and caused the appearance and extension of open, grassy plains. The ancient forest inhabitants were forced either to retreat and disappear with the forests, or to adapt themselves to the new conditions of life. The ancestors of the Horse, following the latter course, changed with the changing conditions, and the race became finally as we see it to-day, one of the most highly specialized of animals in its adaptation to its peculiar environment. At the end of the Age of Mammals the continents stood at a higher elevation than at present, and there was a broad land connection between Asia and North America, as well as those now existing. At this time the Horse became cosmopolitan, and inhabited the plains of all the great continents, excepting Australia.

It is a question whether the direct ancestry of the modern Horse is to be searched for in Western America or in the little known interior plains of Eastern Asia. It is also unknown why the various species which inhabited North and South America and Europe during the early part of the Age of Man should have become extinct, while those of Asia (Horse and Wild Ass) and of Africa (Wild Ass and Zebra) still survive. Man, since his appearance, has played an important part in the extermination of the larger animals; but there is nothing to show how far he is responsible for the disappearance of the native American species of horse.

Parallel Evolution in Other Races.

It is interesting to observe that while the evolution of the Horse was progressing during the Tertiary period in North America another group of hoofed animals, the *Litopterna*, now extinct, in South America evolved a race adapted to the broad plains of Argentina and Patagonia and singularly like the Horse in many ways (see exhibit in A-case in centre of hall). These animals likewise lost the lateral toes one after another, and concentrated the step on the central toe; they also changed the form of the joint-surfaces from ball-and-socket to pulley-wheel joints; they also lengthened the limbs and the neck; and they also lengthened the teeth, and complicated their pattern. Unlike the true Horse, they did not form cement on the tooth, so that it was by no means so efficient a grinder. This group of animals native to South America became totally extinct, and were succeeded by the horses, immigrants from North America, which in their turn became extinct before the appearance of civilized man.

Many of the contemporaries of the Horse in the northern hemisphere were likewise lengthening the limbs, lightening and strengthening the feet, elongating the tooth-crowns to adapt themselves to the changing conditions around them, but none paralleled the Horse Evolution quite so closely as did the pseudo-horses of South America. But the camels in America, the deer, antelope, sheep and cattle in the Old World progressed on much the same lines of evolution, although their adaptation was not to just the same conditions of life.

THE AMERICAN MUSEUM JOURNAL.

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AMERICAN MUSEUM OF NATURAL HISTORY

The

Hawk-Moths of the Vicinity of New York City

BY

William Beutenmüller

Curator of Entomology

SUPPLEMENT TO AMERICAN MUSEUM JOURNAL

VOL. III, No. 2, FEBRUARY, 1903

Guide Leaflet No. 10

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The Hawk-Moths of the Vicinity of New York City

A Guide Leaflet to the Collection on Exhibition
in the
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By

WILLIAM BEUTENMÜLLER
Curator of Entomology

PUBLISHED BY THE MUSEUM
AS SUPPLEMENT TO THE AMERICAN MUSEUM JOURNAL

VOL. III, NO. 2, FEBRUARY, 1903

Guide Leaflet No. 10

THE HAWK-MOTHS OF THE VICINITY OF NEW YORK CITY.

By William Beutenmüller,

Curator of the Department of Entomology.

Family *Sphingidæ*.

The members of the family of Sphingidæ are commonly called "Hawk-Moths" on account of their powerful and rapid flight and their beak-like proboscis. Some of the species are also called Hummingbird Moths, owing to their peculiar habit of hovering like a hummingbird over flowers while drawing up nectar with their long proboscis. Some species fly during mid-day in the hot sunshine, while others fly late in the afternoon and at night.

The moths have long, narrow fore wings, with an oblique, excavated or scolloped outer margin. The hind wings are much shorter, with the outer margin entire, the anal angle usually produced and the apex rounded or pointed.

The head is usually clothed with smooth scales, or has a tuft between the antennæ. The eyes are hemispherical, and as a rule lashed with hairs in front above. The proboscis is well developed in most of the species, and is nearly as long as or longer than the body. When not in use the organ is curled up like a watch-spring, between the palpi. The antennæ are fusiform, ciliate in the male and simple in the female, and with the tip more or less bent into a hook. In some species the antennæ are club-shaped, with a few short, bristle-like hairs at the tip.

The thorax is well developed, either with the vestiture smooth, or with the posterior portion with erect scales, or with the anterior portion with an elevated tuft.

The body usually is long and graceful, with the segments gradually tapering. Some species are provided with a more or less entire fan-like tuft at the end of the body.

The eggs are green, smooth, oval or oblong oval. They are usually laid singly, on the under sides of a leaf, and the young

caterpillar hatches in from five to seven days after the eggs have been deposited. The caterpillars as a rule shed their skins or moult five times before reaching maturity. The mature caterpillars are smooth, or sometimes more or less granulated over the surface. The last segment is provided with a horn, or marked with a tubercle or polished eye-like spot instead. Most of the Hawk-Moth caterpillars are marked with seven lateral, oblique stripes. After reaching maturity, and when ready to transform, they descend from their food-plants to the ground. Most forms burrow into the soil, where they construct cells, in which they change to pupæ, but some species form their pupæ on the surface of the ground, in a loose, web-like cocoon between leaves. The pupæ are almost always chestnut brown, elongate, with the tongue-case either buried or detached and resembling the handle of a pitcher.

KEY TO THE HAWK-MOTHS.

Wings partly transparent......................	Group A.
Wings wholly opaque..........................	" B.
With yellow markings on body................	Section 1.
With yellow markings on hind wings..........	" 2.
With green and pink markings on wings.......	" 3.
With green markings on wings, without pink...	" 4.
With pink markings on wings, without green...	" 5.
With brown markings, without pink, green or yellow..................................	" 6.
With gray or blackish brown markings, without pink, yellow or green.....................	" 7.

Group A.—WINGS PARTLY TRANSPARENT.

Underside of thorax pale yellow without a line on each side.
Outer border of fore wings toothed within....*Hemaris thysbe.*
Like *thysbe*, but larger........................var. *floridensis.*
Outer border of fore wings not toothed within...var. *ruficaudis.*
Underside of thorax pale yellow with a red-brown line on each side.
Outer border of fore wings even within.....*Hemaris gracilis.*

Underside of thorax pale yellow with a black line on each side.
Outer border of fore wings broad; toothed within.
Hemaris axillaris.
Like *axillaris*, but with outer border of fore wings not toothed within........................var. *marginalis.*
Outer border of fore wings narrow..........*Hemaris diffinis.*

Group B.—WINGS WHOLLY OPAQUE.

Section 1.—**With yellow markings on body.**

Abdomen with large yellow spots on each side.
Fore wings light gray..*Phlegethontius quinquimaculatus.*
" " dark gray........*Phlegethontius carolina.*
" " sooty brown with white lines.
Phlegethontius rusticus.

Abdomen with two yellow transverse lines.
Fore wings rich brown with darker velvety brown band........................*Amphion nessus.*

Section 2.—**With yellow markings on hind wings.**

Fore wings chocolate brown with darker markings.
Hind wings yellow at base.........*Sphecodina abbotii.*

Fore wings rich brown with lilac lines.
Hind wings yellow, with an eye-like spot.
Smerinthus myops.

Fore wings almost uniform orange brown with lilac streaks.
Hind wings uniform orange with an eye-like spot.
Smerinthus astylus.

Fore wings ochre brown with oblique lines.
Hind wings black with a row of yellow spots.
Theretra tersa.

Fore wings brown, veins finely marked with black.
Hind wings ochre yellow, with a black outer band.
Sphinx lucitiosa.

Section 3.—**With green and pink markings on wings.**

Fore wings olive green with a broad buff band from base to tip: veins partly marked with white.

Hind wings pale green at base, marked with black, pink outwardly . . . . *Philampelus vitis.*

Fore wings similar to *vitis* but darker.

Hind wings not pink outwardly, except at anal angle. *Philampelus linnei.*

SECTION 4.—**With green markings on wings, without pink.**

Fore wings an almost uniform green.

Hind wings marked with blue . . . . . . *Argeus labruscæ.*

Fore wings green with whitish and pinkish lines.

Hind wings rusty brown with gray outer margin. *Ampelophaga versicolor.*

Fore wings olive gray with more or less distinct olive green band and shades.

Hind wings rusty brown with a gray patch at anal angle. . . . . *Ampelophaga myron.*

Fore wings pale olive with rich dark green shades and patches.

Hind wings pale green with large black patches. *Philampelus pandorus.*

SECTION 5.—**With pink markings on wings, without green.**

Fore wings gray, with darker markings.

Body with a row of rose-colored spots on each side. *Phlegethontius cingulatus.*

Fore wings pale chocolate brown with rich velvety brown patches.

Hind wings pink, outwardly chocolate brown. *Philampelus achemon.*

Fore wings dark olive brown with a buff-colored oblique band from base to tip; veins marked with white.

Hind wings black with a broad pink band. *Deilephila lineata.*

Fore wings olive brown with an oblique buff band; veins not marked with white.

Hind wings with a pinkish band. *Deilephila galii*, form *intermedia.*

Fore wings gray with a pinkish tinge, and deep brown markings.

Hind wings red at base with an eye-like spot.
Smerinthus geminatus.

Fore wings rich brown with a rosy tint.
Hind wings rose color with an eye-like spot.
Smerinthus excæcatus.

Fore wings gray with an olive gray median band.
Hind wings marked with claret red.
Amorpha modesta.

SECTION 6.—**With brown markings, without pink, green or yellow.**

Fore wings rusty brown, basal half paler.
Hind wings rusty brown. . . . . . . *Ampelophaga chœrilus.*

Fore wings chocolate brown with darker shades outwardly.
Hind wings almost uniform chocolate brown.
Enyo lugubris.

Fore wings sooty brown with two rows of white spots and bands not running across the wing.
Hind wing sooty black.
Abdomen with a white band . . . . . *Aëllopos tantalus.*

Fore wings sooty brown with white lines and shades.
Hind wings blackish brown with incomplete white bands. . . . . *Dolba hylæus.*

Fore wings light and dark chestnut brown in form of streaks.
Hind wings brownish white with a central and an outer black band . . . . *Sphinx kalmiæ.*

Fore wings ashen brown with black dashes.
Hind wings black with two dirty white bands.
Sphinx eremitus.

Fore wings coffee brown, pale along the outer and costal parts and with black streaks between the veins.
Hind wings brown with an ill-defined band in middle. . . . . *Ceratomia amyntor.*

Fore wings sepia brown with lighter scales, and with black dashes near the tip.
Hind wings uniform sepia brown. . .*Ceratomia catalpæ.*

Fore wings mouse gray with a toothed transverse line and two black dashes.

Hind wings uniform warm brown, tipped with white. *Lapara coniferarum.*

Fore wings with a double-toothed transverse line and two angulated lines.

Hind wings as in *coniferarum*.... *Lapara bombycoides.*

Fore wings light gray, sometimes streaked with brown.

Hind wings rusty brown with darker outer border. *Dilophonota ello.*

Fore wings dark brown with ash-gray markings.

Hind wings dull rusty brown..... *Deidamia inscripta.*

Fore wings light ochre brown, sometimes marked with darker brown.

Hind wings similar, with two narrow lines. *Cressonia juglandis.*

SECTION 7.—**With gray or blackish brown markings, without pink, yellow or green.**

Hind wings with a white band.

Fore wings ash gray with four black streaks between the veins.

Thorax gray with two black lines... *Sphinx chersis.*

Fore wings dirty gray with black dashes.

Thorax dull gray with two obscure black lines; sides whitish.................... *Sphinx canadensis.*

Fore wings sooty black, grayish in the middle.

Thorax brown black; side gray.... *Sphinx gordius.*

Fore wings deep sooty blackish brown, pale gray along the costal region.

Thorax deep brownish black, sides pale grayish. *Sphinx drupiferarum.*

Hind wings without white band.

Fore wings gray with many dark transverse wavy lines.

Thorax grayish bordered with black. *Ceratomia undulosa.*

Fore wings light gray with a prominent oblique black dash.............. *Chlænogramma jasminearum.*

Fore wings gray streaked with black and with a white dot near the middle...... *Sphinx plebeius.*

1. *Hemaris thysbe.* 2. *H.*, var. *ruficaudis.*
3. *H.*, var. *floridensis.*

Very common, especially in gardens. Double-brooded. It flies in the day in the sunshine during the latter part of May and early June and again late in July and early in August. The variety *ruficaudis* (Fig. 2) is less common than *thysbe.* A second variety, *floridensis,* is very rare in this vicinity, but is common southward. The species ranges from Labrador to Florida and westward to the Mississippi. The caterpillar feeds on different kinds of *Viburnum.* Forms a pupa on the ground in a loose cocoon.

4. *Hemaris gracilis.*

Very rare in this neighborhood. Double-brooded, appearing

in May and June and again in July and August. It is closely allied to *H. thysbe* var. *ruficaudis*, but differs therefrom by its smaller size and by having a red stripe on each side of the thorax beneath, and three rows of white spots on the under side of the abdomen. It flies during the day in the sunshine.

5. *Hemaris diffinis.*

In the immediate vicinity of New York this species is very rare. It is found from Canada to Florida, and westward to Missouri and Iowa. In certain localities it is rather common. Found during the latter part of May and early in June and again during July and August. It flies during the day in the sunshine. The caterpillar feeds on snowberry (*Symphoricarpus*), feverwort (*Triosteum perfoliatum*) and bush-honeysuckle. Forms a pupa on the ground in a loose cocoon.

6. *Hemaris axillaris.*

Very rare in this vicinity, but more abundant in the Western States. It is found from New York to Texas. In general appearance it resembles *H. diffinis*, but the outer border of the fore wing is broader, and is more or less toothed inwardly, while in *diffinis* it is even. The body is longer. The moth flies during the day in the sunshine. The caterpillar feeds on different kinds of honeysuckle. Forms a pupa in a loose cocoon on the ground.

7. *Aëllopos tantalus.*

This southern species is found occasionally in this vicinity. It may be known by its sooty black color and the white third segment of the body. It flies during the daytime in the hottest sunshine. The early stages are unknown.

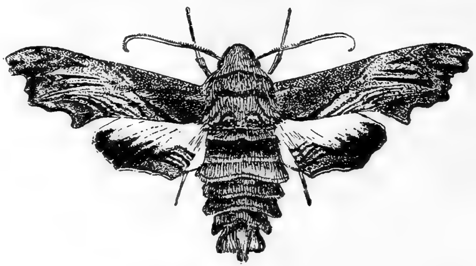
8. *Enyo lugubris.*

A southern species very rarely found in this vicinity. It is common in the Southern States, Mexico and the West Indies.

9. *Amphion nessus.*

Rich dark brown with darker velvety markings and two

yellow transverse bands on the abdomen. It is found late in May and early in June and again in August. It flies during the hottest sunshine and also in the evening. Found from Canada to Florida, and westward to Iowa. The caterpillar feeds on grape, willow-herb (*Epilobium*) and Virginia creeper. Forms a pupa in a loose cocoon on the ground.



10. *Sphecodina abbotii.*

Very common in this vicinity. The moth appears in May and June and again during the latter part of July and early in August. Found from Canada and Eastern States westward to Iowa. The caterpillar feeds on grape and Virginia creeper. It enters the ground to pupate.

11. *Deidamia inscripta.*

Not common in this vicinity. The moth makes its appearance during the latter part of May and the first days in June. Found from Canada to Virginia and westward to the Mississippi valley. The caterpillar feeds on grape and Virginia creeper. Enters the ground to pupate.

12. *Deilephila lineata.*

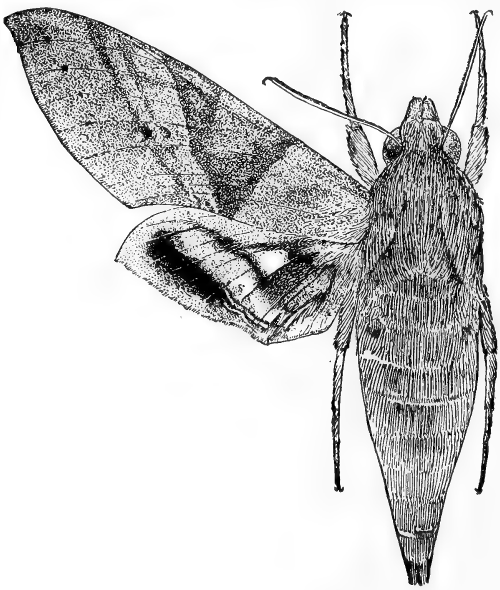
This species is found in the United States, Canada and Cuba. In this vicinity common everywhere. It flies early in the evening and often in bright daylight. The insect is double-brooded, the first brood appearing during June and July, and the second during the latter part of August and early in September. The caterpillar feeds on purslane, buckwheat, turnip, watermelon, chickweed, dock, evening primrose, apple, currant, grape and gooseberry. Enters the ground to pupate.

13. *Deilephila galii*, form *intermedia.*

Not common in this vicinity. Found during June and again in August. It is found from Canada to Georgia and westward to California, also found in Europe. The pink median band on the hind wings in the European form (*galii*) is much paler than in the American form (*intermedia*). The caterpillar feeds on purslane, evening primrose and willow-herb (*Epilobium*). Enters the ground to pupate.

14. *Theretra tersa.*

Quite rare in this vicinity, but common in the Southern States, West Indies, Central and South America. It ranges northwardly as far as Canada. It is usually found in flower gardens. The caterpillar feeds on *Bouvardia*, buttonweed (*Spermacoce glabra*) and *Manetta bicolor*. Enters the ground to pupate.



15. *Argeus labruscæ.*

A South American species, occurring northward to Canada. In the north it is an occasional visitor, and is very rarely taken.

16. *Philampelus pandorus.*

Rather common in this vicinity, in gardens and vineyards. It is double-brooded, the first brood appearing during June and early in July, and the second in August. Found in the United States east of the Great Plains and also in Canada. The caterpillar feeds on grape and Virginia creeper. It enters the ground to pupate.

17. *Philampelus achemon.*

This species is double-brooded, the first brood appearing in

June and July, and the second in August. It is found throughout the United States and Canada. The caterpillar feeds on grape and Virginia creeper. Enters the ground to pupate.

18. *Philampelus vitis.*

This species has been recorded from South America, Central America, Cuba, Texas, Florida, and along the Atlantic coast to Massachusetts. It is a southern species, and is very rarely taken in this vicinity. The caterpillar feeds on grape. Enters the ground to pupate.

19. *Philampelus linnei.*

Inhabits South and Central America, Cuba and the Southern

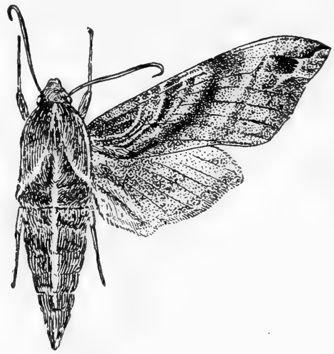
States, and is said to be found northward as far as Massachusetts. It is closely allied to *P. vitis*, but is much darker.

20. *Ampelophaga chærilus.*

This is a rather common species, and is found in open woods. It may be known readily by its rusty brown color. Found from Canada to Georgia, and westward to Iowa. Double-brooded; on the wing from June to August. The caterpillar feeds on different kinds of *Viburnum*, sour-gum and azalea. It spins a rude cocoon amongst leaves on the surface of the ground.

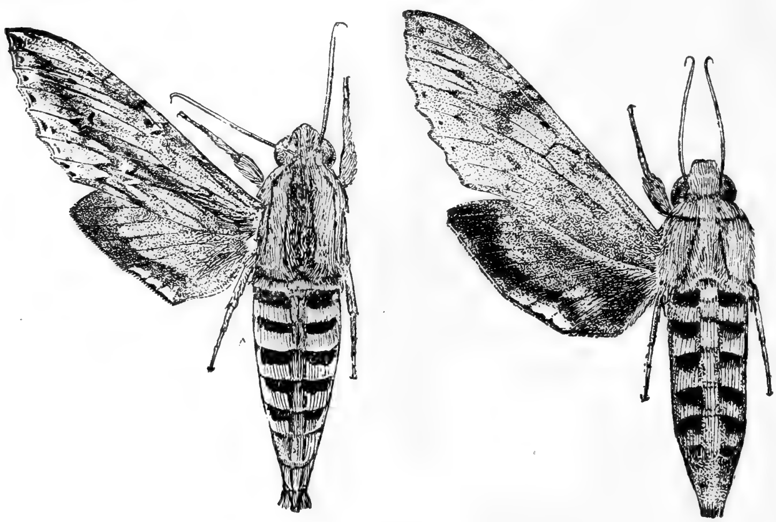
21. *Ampelophaga myron.*

Rather common in gardens about grapevines. It is double-brooded, the first brood appearing in June and July and the second in August. Found from Canada to Florida, and westward to Missouri and Iowa. The caterpillar feeds on grape. Spins a loose cocoon among leaves on the ground.



22. *Ampelophaga versicolor.*

Quite rare and local in this vicinity. The moth may be known by the bright green coloring on the fore wings, with more or less distinct whitish transverse lines. It is double-brooded, the first brood appearing in June and early in July and the second in August. The caterpillar feeds on button-bush (*Cephalanthus occidentalis*) and swamp-loose-strife (*Nesæa verticillata*). Spins a loose cocoon among leaves on the ground.



23. *Dilophonota ello.*

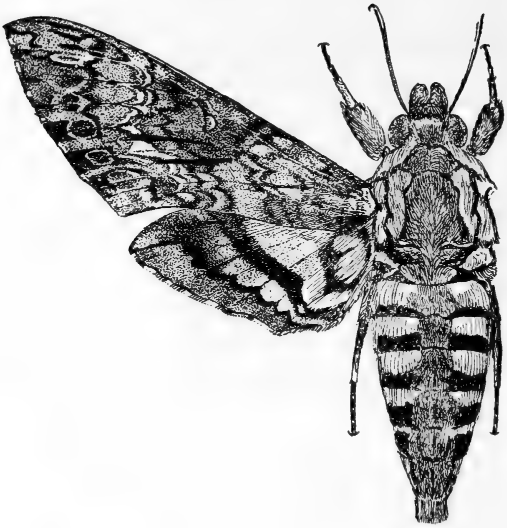
A common southern species, but rarely found in this vicinity. It is found from Brazil northward to Canada.

24. *Phlegethontius quinquimaculatus.*

Common and double-brooded in this vicinity. The first brood appear in June, and the second in August. It is found throughout the United States and Canada. The caterpillar feeds on tomato, tobacco, Jamestown-weed (*Datura*), matrimony-vine (*Lycium vulgare*) and ground-cherry (*Physalis viscosa*). The pupa has a long arched tongue-case. Enters the ground to pupate.

25. *Phlegethontius carolina.*

Found in the United States from the Atlantic to the Pacific, in Canada, Mexico, and the West Indies. It is common and double-brooded in this vicinity. The caterpillar feeds on tomato, tobacco, Jamestown-weed (*Datura*) and matrimony-vine. Enters the ground to pupate.



26. *Phlegethontius cingulatus.*

May be known readily by the rose-red spots on the abdomen. It is found from Canada to Brazil, and to the west coast of our continent, and also in the Hawaiian Islands. Double-brooded; the first brood appears in June and the second in August and September. Enters the ground to pupate.

27. *Phlegethontius rusticus.*

A common southern species rarely taken in this vicinity. Its range of distribution extends from South America northward to

New York; also found in the West Indies. The caterpillar feeds on lilac, privet and fringe-bush (*Chionanthus*). Enters the ground to pupate.

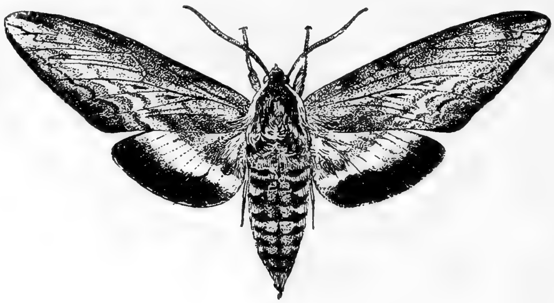
28. *Sphinx drupiferarum.*

Not common in this vicinity. Double-brooded, appearing in June and again early in August. Found from Canada to Florida and westward. The caterpillar feeds on apple, plum and cherry. Enters the ground to pupate.

29. *Sphinx kalmiæ.*

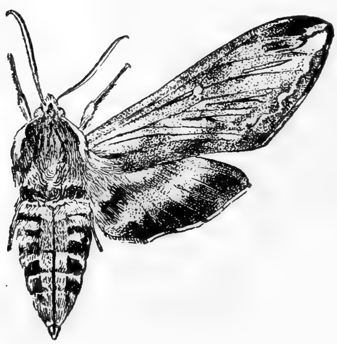
Not common. Double-brooded. It is on the wing in June and again late in July and early in August. Found from Canada

to Georgia and westward to Missouri. The caterpillar feeds on lilac and laurel. Enters the ground to pupate.



30. *Sphinx lucitiosa.*

Very rare in this vicinity. Double-brooded. The moth is on the wing in June and again in August. The caterpillar feeds on willow and poplar. Enters the ground to pupate.



31. *Sphinx gordius.*

Rather common, but not abundant in this vicinity. Double-brooded, appearing in June and July and again in August. It ranges from Canada to Georgia and westward to the Mississippi, and probably farther westward. The caterpillar feeds on apple, pear, ash and wax-myrtle (*Myrica*). Enters the ground to pupate.

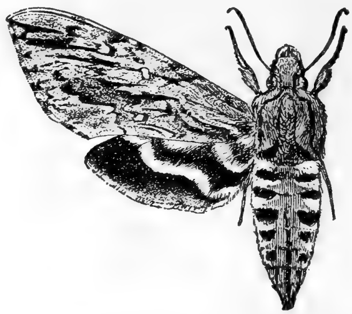
32. *Sphinx chersis.*

Double-brooded in this vicinity, appearing in May and June and again late in July and early in August. Found from Canada to Florida, and westward to the Pacific coast. The caterpillar feeds on lilac, ash and privet. Enters the ground to pupate.

33. *Sphinx canadensis.*

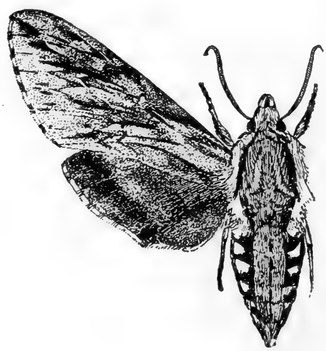
Found in Newfoundland, Canada, New England States to New York and Ohio. It is a very rare species, and has not been

found in this vicinity, but it should be searched for. The early stages are unknown.



34. *Sphinx eremitus.*

Quite rare and local in this vicinity It is double-brooded. The caterpillar feeds on spear-mint (*Mentha*) and wild bergamot (*Monarda*). Enters the ground to pupate.



35. *Sphinx plebeius.*

Rather common. Usually found in gardens about the trumpet-vine, which is the food of the caterpillar. It is double-brooded, appearing in June and again late in July and early in August. Found from Canada to Florida and westward to the Mississippi. Enters the ground to pupate.

36. *Chlænogramma jasminearum.*

Quite rare and double-brooded. It is found from Canada to Georgia and westward. The caterpillar feeds on ash. Enters the ground to pupate.

37. *Ceratomia amyntor.*

Rather common. Double-brooded. Found from Canada to Virginia, westward to Missouri and Iowa. The caterpillar feeds on elm, birch and linden. Enters the ground to pupate.

38. *Ceratomia undulosa.*

Rather common and double-brooded in this vicinity, the first brood appearing in June and the second in August. It is found from Canada to Carolina, and westward to Iowa. The caterpillar feeds on ash, lilac and privet. Enters the ground to pupate.

39. *Ceratomia catalpæ.*

A southern species gradually extending its range northward. It is exceedingly common in the vicinity of Philadelphia, where

the catalpa trees are sometimes completely defoliated by the caterpillars. The species has made its appearance at Lakehurst, New Jersey, and without doubt before long will be found in this vicinity. The caterpillars are social and live in large colonies, differing in this respect from all other species of Sphingidæ. Enters the ground to pupate.

40. *Dolba hylæus.*

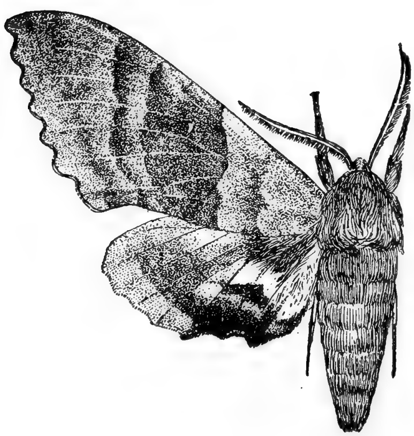
Not common in this vicinity. In general appearance it resembles a miniature *Phlegethontius rusticus* (No. 27). It is found from Canada to Florida and westward to Iowa. The caterpillar feeds on the ink-berry (*Ilex glabra*). Enters the ground to pupate.

41. *Lapara coniferarum.*

Very rare in this vicinity. Found from Canada to Florida, The caterpillar feeds on pine. Enters the ground to pupate.

42. *Lapara bombycoides.*

Very rare in this vicinity. Found from Canada to Florida, and westward to the Mississippi. The caterpillar feeds on pine. Enters the ground to pupate.



43. *Amorpha modesta.*

Rather scarce in this vicinity, but more common in the Northern and Western States. It appears in the latter part of July and August, and may be double-brooded. The caterpillar feeds on willow and poplar. Enters the ground to pupate.

44. *Smerinthus geminatus.*

A common species in this vicinity. It is double-brooded, the first brood appearing in June and July, and the second in August. The moth varies from light to dark gray on the fore wings. Found from Canada to Virginia and westward to Iowa. The caterpillar feeds on willow, poplar, plum, apple, elm, ironwood, hazel, hornbeam, birch, ash etc. Enters the ground to pupate.

45. *Smerinthus excæcatus.*

Common in this neighborhood. Double-brooded, appearing in June and July and again in August. It is found throughout the eastern United States and Canada. The caterpillar feeds on cherry, plum, apple, pear, raspberry, rose, elm, oak, hazel, hornbeam, ironwood, birch, willow, poplar, ash etc. Enters the ground to pupate.

46. *Smerinthus myops.*

Sometimes rather common. It is double-brooded, the first brood appearing in June and July and the second in August. Found from Canada to Florida and westward to the Mississippi. The caterpillar feeds on wild and cultivated cherry. Enters the ground to pupate.

47. *Smerinthus astylus.*

This rare species may be known by its plain orange brown colors and markings. Double-brooded, the first brood appearing late in May and early in June, and the second coming out in July and August. Found from Canada to Pennsylvania, and probably also southward and westward. The caterpillar feeds on huckleberry, dangleberry and *Andromeda ligustrina.* Enters the ground to pupate.

48. *Cressonia juglandis.*

Not rare in this vicinity. Double-brooded. The first brood appears in June and the second in August. The species is subject to considerable variation; some specimens are uniformly pale fawn color or ochraceous, with the transverse lines distinct, while other examples are more or less covered with dark brown so as to almost obscure the ground color and transverse lines. It is found from Canada to Florida and westward to the Mississippi and Texas. The caterpillar feeds on walnut, butternut, hickory and ironwood. Enters the ground to pupate.

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The Musical Instruments of the Incas

BY

Charles W. Mead

Assistant, Department of Archæology

SUPPLEMENT TO AMERICAN MUSEUM JOURNAL

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The Musical Instruments of the Incas

A Guide Leaflet to the Collection on Exhibition
in the
American Museum of Natural History

By

CHARLES W. MEAD
Assistant in Archæology

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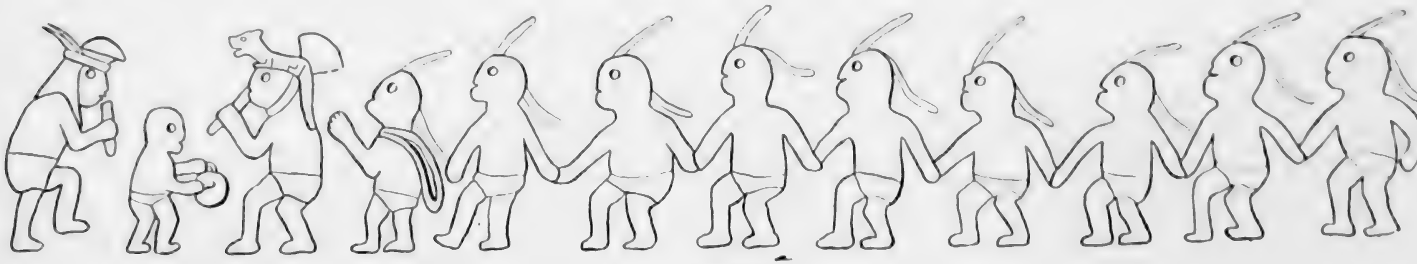


FIGURE 1

FIGURE 2

PLATE I. DECORATIONS FROM ANCIENT PERUVIAN TERRA COTTA VESSELS

THE MUSICAL INSTRUMENTS OF THE INCAS.

By Charles W. Mead,

Assistant, Department of Archæology.

INTRODUCTION

Ancient Peru, the land of the Incas, extended, according to the historians, Garcilasso de la Vega [1] and Prescott, [2] from about the second degree of north latitude to the Maule River in Chile, about the thirty-sixth degree of south latitude. The country included the region now comprised within the Republic of Peru, and the greater part of Ecuador, Bolivia and Chile, and was nearly equal in size to that part of the United States east of the Rocky Mountains. The Incas had no written language, and no small part of our knowledge of their customs has been derived from their practice of representing the scenes of daily life in the decoration of their pottery vessels. In the study of the musical instruments in particular, the decorations on the pottery of the ancient Peruvians is important, because the Spanish conquerers of the land and their followers have left in their accounts but little information bearing upon the subject. From the pottery and other objects found in the ancient tombs and burial places, therefore, we have derived most of our knowledge of the musical instruments of the Incas, and the present discussion is based upon a study of the prehistoric Peruvian collections in the American Museum of Natural History. In these collections there are not only many of the musical instruments themselves, but also artifacts, principally pottery vessels, decorated with figures of men in the act of playing upon such instruments.

It is commonly said that "Peru is a puzzle"; and certainly this may be truthfully said of its music. Although we find recorded a number of characteristic songs, known to the Peruvian Indians for nearly two hundred years, we cannot say positively of any one of them that it is wholly pre-Spanish. Dr. von

[1] Royal Commentaries of Peru. Ed. Rycaut, Part I, Book I, Chap. III.

[2] Conquest of Peru, Vol. I, p. 28.

Tschudi has published three Peruvian elegiac songs or *haravis* [1] which he says "might serve to test the musical knowledge of the ancient Peruvians," but an examination of these pieces is very disappointing. Carl Engel remarks:

"At all events they must have been tampered with, as they exhibit exactly the form of the Spanish *bolero*. Even allowing that the melodies of these compositions have been derived from Peruvian *haravis*, it is impossible to determine with any degree of certainty how much in them has been retained of the original tunes, and how much has been supplied besides the harmony, which is entirely an addition of the European arranger." [2]

The first and simplest element of music is rhythm, and in singing or dancing a desire for some sound that shall clearly mark it is universal; hence, in the absence of musical instruments, the custom of snapping the fingers, clapping the hands, beating the hips and stamping the feet; and I am inclined to follow Rowbotham [3] in believing that the art of instrumental music in prehistoric times passed through three stages, which may be designated the "drum" type, the "pipe" type, and the "lyre" type. The first type includes all instruments of percussion, as drums, rattles, gongs, castanets, etc.; the second, all wind instruments, and the third, all stringed instruments. In support of this theory he cites the evidence furnished by the mechanical complexity of the instruments themselves. The drum is the simplest form; the pipe is more complex than the drum; and the lyre, which makes use of stretched strings, is the most complex of all.

That the drum was the first instrument of primitive man is strenuously opposed by Wallaschek, who says:

"The most ancient discoveries (from the youth of mankind) of flutes and pipes, but not of drums, are definite facts which no speculation can put aside, and I am rather inclined to believe that Wagener was correct in saying that a wind instrument was undoubtedly the first." [4]

[1] Antigüedades Peruanas, pp. 135, 136.
[2] Musical Instruments, p. 79.
[3] Journal Anthro. Institute Gr. Brit. and Ireland, Vol. X, pp. 380–381.
[4] Primitive Music, p. 84.

The entire absence of drums and the large number of flutes in the prehistoric Peruvian collections in museums would seem to support this claim in Peru were it not for the fact that numerous pottery vessels decorated with figures in the act of beating the drum are found with mummies in the ancient graves. (See Plates I and II.)

The fact that a tribe has flutes and no drums is not proof that their earliest instrument was not the drum. There are well-known cases of the "dropping out" of musical instruments. In Guatemala the *marimba* has become a national instrument. Professor O. T. Mason, referring to this instrument, says:

> "In one case we have a musical instrument imported by negro slaves given to the Indians with its native African name and abandoned by the negroes themselves." [1]

INSTRUMENTS OF PERCUSSION.

Drum

In instruments of this class the drum undoubtedly held the first place, although, as has been stated, none has been found in the ancient graves up to the present time. This may be accounted for by the perishable material of which they were made; or, through the existence of some superstition on account of which they may never have been buried with the dead. However this may be, the numerous representations on pottery vessels, and the accounts of early writers, give us a pretty accurate idea of their form and construction.

The drums appear to be identical with those in use in many parts of Peru to-day and were made by stretching a skin over a hoop of wood or over one end of a short section of the trunk of a tree which had been hollowed out to a thin cylinder. These two forms of drum are shown on Plate II, where two men (figs. 7 and 10) are beating very thin drums, which would seem to represent the hoop form, while another drummer (fig. 9) plays upon one much thicker, which is probably of the second type. Judging from these representations, the drums would not exceed fourteen or fifteen inches in diameter. We are told frequently by early writers that small drums were used on different occasions; but

[1] American Anthropologist, Vol. X, No. 11.

no mention of larger ones, so common in many Indian tribes, has been found. The Abbé Molina, describing the method of curing the sick, says:

"The *Machi* directs the women who are present to sing with a loud voice a doleful song, accompanied with the sound of some little drums, which they beat at the same time." [1]

Doubtless the heads of these drums were usually made of the skin of the deer and other animals common to the country, but this was not always the case. The Huancas "flayed the captives they took in war, making some of the skins into drums." [2] Garcilasso says:

"They were a sort of fierce and warlike people fleaing those whom they took in the wars, the skins of which they filled with ashes and hanged them up in the temples for trophies; with the skins of some they make drums, being of opinion that the sound of them would terrify their enemies." [3]

Bell

Copper bells, in form resembling our sleigh-bells, appear to have been in common use. Figs. 2, 3, and 4 of Plate II show three, each of which has a pebble in the cavity. Fig. 1 shows a flattened form, decorated on either side with a figure, probably representing the sun. This bell has been broken, and the pebble or "clapper" is missing. Cieza de Leon, who is perhaps the most reliable of the contemporaneous writers, remarks:

"When the chiefs [Guayaquil, Ecuador] were sick, to appease the wrath of their gods, and pray for health, they made other sacrifices of a superstitious nature; killing men (as I was told), and believing that human blood was a grateful offering. In doing these things they sounded drums and bells before certain idols shaped like lions and tigers, which they worshipped." [4]

In the Museum collection there are three bronze objects, circular in outline and slightly concavo-convex, each having a

[1] History of Chili, p. 92.
[2] Travels of Cieza de Leon, Ed. Hakluyt, Part I, p. 299.
[3] Royal Commentaries of Peru, Ed. Rycaut, Part I, Book VI, Chap. X.
[4] Travels of Cieza de Leon, Ed. Hakluyt, Part I, p. 203.

PLATE II

projection perforated for suspension. When struck with any hard substance, they give out a remarkably clear and resonant sound. One of these is shown as fig. 12 of Plate II. It is three and seven-eighths inches in diameter. Ewbank, describing Señor Barboza's collection of Peruvian antiquities, figures three of these objects, two of which he states are of copper and one of bronze. He says: "I took them for mirrors; but they do not seem to have been polished."[1] None of the three in the Museum shows any indication, on either side, of having been polished, and there seems to be no reason to doubt that they were used as gongs or bells.

Rattle and Cymbal

Of the various forms of rattles it is hardly necessary to speak in detail. They consisted of small shells and nuts, seeds of a species of laurel tree, etc., and were often strung together. (See Plate II, fig. 8 and Plate III, figs. 5, 7, 8.) These were attached to the wrists, ankles and other parts of the body in dancing. A common form of rattle was a gourd containing seeds or pebbles. The use of shells as paint cups or palettes was very common, as is attested by numerous specimens, which still contain paint, found in graves; but their use as musical instruments in ancient Peru, has not been noticed before. Figs. 5 and 6 of Plate II represent water vessels of terra cotta, decorated with figures striking shells together, as cymbals are played. The "cymbals" are so well modeled that there can be no doubt that they represent Spondylus (*Spondylus pictorum*, Chem.) shells. (See Plate II, fig. 11).

WIND INSTRUMENTS.

Syrinx or Pan-pipe

Long before the conquest the Peruvians had emerged from the first or drum stage, and reached the second, which C. K. Wead defines as that "having instruments mechanically capable of furnishing a scale"[2]—a tremendous stride in the art. The most important instruments of this class are the syrinx or Pan-pipe (*huayra puhura*) and the flutes of bone and cane. Fig. 7 of Plate IV shows a syrinx

[1] Life in Brazil, Appendix, p. 454.
[2] Contrib. to the Hist. of Musical Scales, Rep. U. S. Nat. Mus., 1900, p. 421.

consisting of eight reeds of graduated lengths, held in position by a crosspiece of split cane lashed to the reeds with a cord made of the wool of the llama. This pipe has all the reeds open at the lower ends, and yields the following scale:

Other Pan-pipes are found with reeds closed at the lower end; and still another form has a double set of the same dimensions, —one set open at the bottom and the other closed, those of corresponding length being placed opposite each other. By this arrangement octaves are produced, the closing of a pipe at one end, as is well known, lowering its pitch an octave. This same law is utilized by the modern organ builder in the employment of the so-called open and stopped diapasons.

A curious and unique syrinx of stone is shown as fig. 3 of Plate III. The illustration is made from a plaster cast. The original, which was procured by the French general Paroissien, is made of greenish talc, and is said to have been found on a mummy in a Peruvian tomb. This interesting specimen has been described at length by Carl Engel.[1] Figs. 1 and 2 of Plate IV represent water jars, in human form, made of terra cotta; both figures are represented in the act of playing the Pan-pipes. Garcilasso says:

"In music they arrived to a certain harmony, in which the Indians of Colla did more particularly excel, having been the inventors of a certain pipe made of canes glued together, every one of which having a different note of higher and lower, in the manner of organs, made a pleasing music by the dissonancy of sounds: treble, tenor and bass, exactly corresponding and answering each to other; with these pipes they often played in consort, and made tolerable music, though they wanted the quavers, semiquavers, airs, and many voices which perfect the harmony amongst us."[2]

These pipes are as popular with the modern Indians as they

[1] Musical Instruments, p. 66.

[2] Royal Commentaries of Peru, Ed. Rycaut, Part I, Book II. Chap. XIV.

were with their ancestors in the days of the Incas. Indian couriers frequently use this instrument to announce their arrival and departure, as the post-horn was used by the driver or guard of a mail coach in England, and as it is now used by a New York coaching party.

E. G. Squier, who witnessed the *chuño* or potato festival of the Aymará Indians, says:

"Each group danced vigorously to its united music, which made up in volume what it lacked in melody—wild and piercing, yet lugubrious: the shrill pipe [Pan-pipe] and the dull drum, with frequent blasts on cow's horns by amateurs among the spectators, filled the ear with discordant sounds. Every man seemed anxious to excel his neighbor in the energy of his movements, which were often extravagant; but the motions of the women were slow and stately. The music had its cadences, and its emphatic parts were marked by corresponding emphatic movements in the dance. The 'devilish music' that Cortez heard after his first repulse before Mexico, lasting the livelong night, and which curdled his blood with horror, while his captured companions were sacrificed to Huitzlipochtli, the Aztec war-god, could not be stranger or more fascinating, more weird or savage, than that which rung in our ears during the rest of our stay in Tiahuanaco." [1]

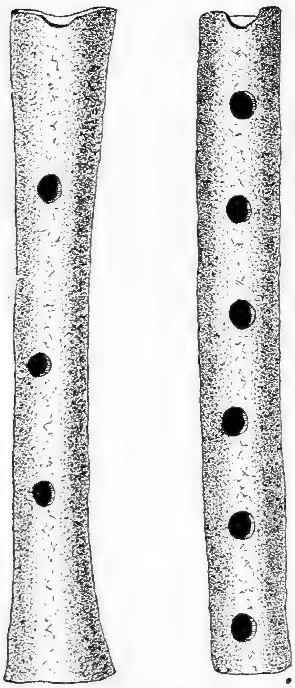
Lieut. Gibbon describes the "church performances" of the Aymará Indians thus:

"The wind-instruments are made of a succession of reeds of different sizes and lengths [Pan-pipes], upon which they blow a noise, little resembling music to our ear, keeping time with the drummers, the slow-motioned dancers respecting them both. . . . The women again appeared, each bringing with her a jar of *chicha*, which they served out in cups, giving to each individual as much as he could drink, which was no small quantity, for the morning was cold. The music again struck up, and the women again joined in the dance. One of them came out with her sleeping 'wawa' slung to her back, which soon commenced a laughable discord; but not a smile could be discovered in any of their faces; neither did the woman stop till the dance was ended." [2]

[1] Travel and Exploration in the Land of the Incas, pp. 306, 307.

[2] Exploration of the Valley of the Amazon, Part II, pp. 117, 118.

Bearing this description in mind, it will be interesting to turn to Plate I, fig. 2, which represents figures of men and women in relief, forming a band around a pottery water vessel. There is every reason to believe that the potter who moulded these figures was gathered to his fathers long before the coming of the Spaniards, yet he depicts the identical scene described by Lieut. Gibbon after so great a lapse of time; showing how such customs persist with these Indians. The musicians play upon Pan-pipes and the drum. The woman with her "wawa" (baby) strapped to her back is here, nor are the jars of chicha wanting. Chicha is a fermented drink made of maize, and is still the national drink of the Indians. J. S. Skinner relates that,



BONE FLUTES ¾

"In alternation of dancing, singing, and drinking they remain for several days and nights without intermission, until all the jars are empty. Father Figueroa pleasantly observes that he is at a loss to conjecture how they have a head for so much noise, a throat for so much exclamation, and a tooth for so much liquor." [1]

Flute

On Plate V, twenty-six flutes are represented. Nos. 1, 2 and 3 are of cane; Nos. 7, 8 and 9 are made from the wing bone (ulna) of the pelican; Nos. 11, 12, 14, 15 and 16 from combined ulna and radius of the llama; No. 13 is a small gourd. All the others are made from the ulnæ of deer. They are simply tubes, open throughout their length, and all belong to the class known as "end-blown."

In playing, the breath, crossing the opening at the upper end, impinges on the sharp edge, which is often notched, setting up vibration in the column of air within the instrument, thus producing the sound. It is a well-known law that the frequency of vibration,

[1] Present State of Peru, p. 290.

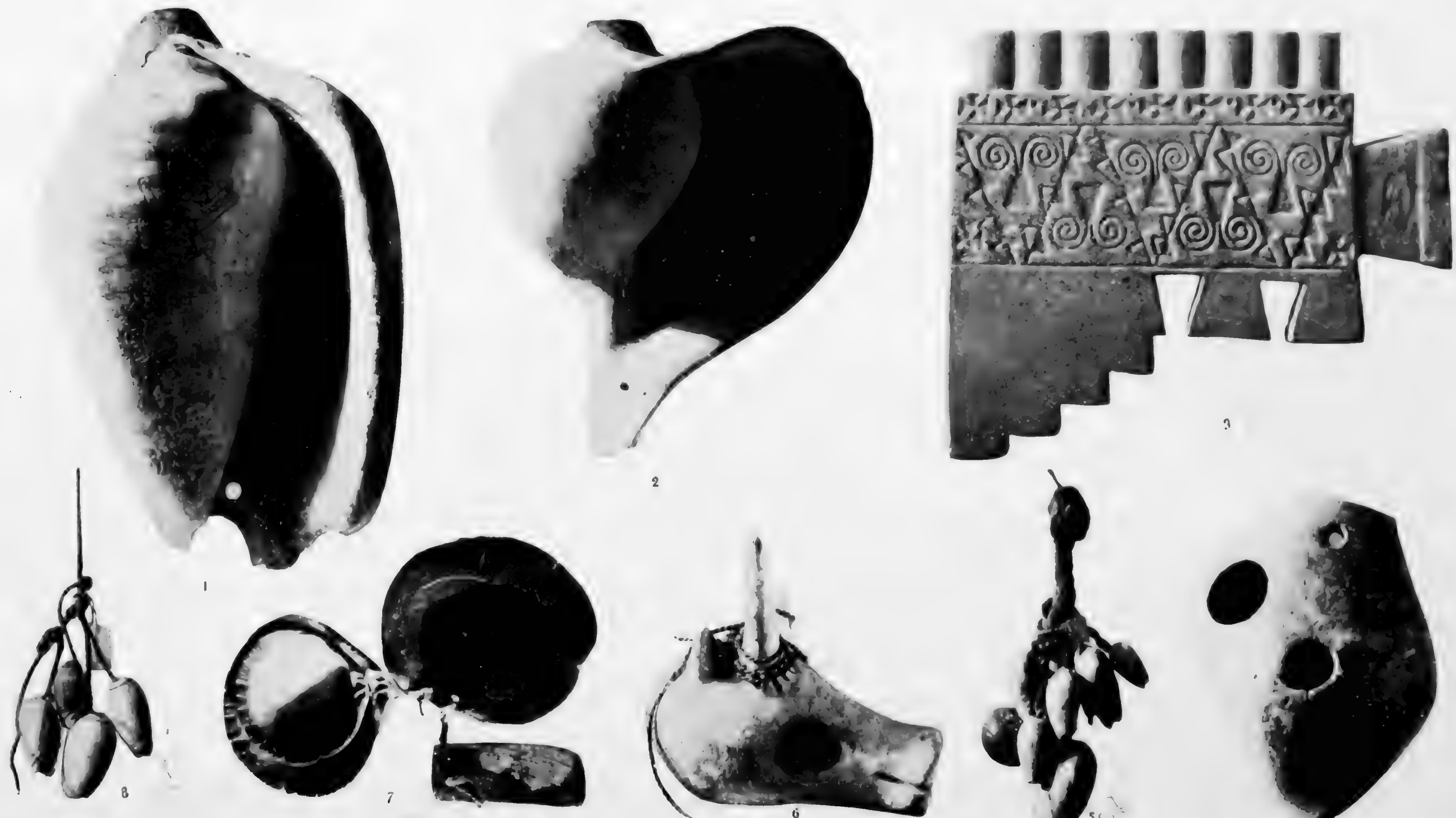


PLATE III

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or, in other words, the pitch of a note produced, depends chiefly on the length of the column of air within the flute.

In the flutes represented the vents or holes for changing the length of the vibrating column of air vary in number from three to seven. In those made of cane they are all on the upper side, while the bone flutes often have one of the holes on the under side, which was closed by the thumb. Nos. 4, 5, 6, 10, 11, 14 and 17 to 26 are of the latter kind.

All attempts to discover any rule or law governing the positions of the openings or vents have been unsuccessful. A first glance at several of these flutes, particularly those made of cane, gives the impression that an attempt at equal spacing had been made; but a second shows such a variation in distances that this seems doubtful. The bone flutes (figs. 25 and 26, Plate V) are of the same length, yet a great difference in the position of the holes is apparent at a glance. We are led to the conclusion that these ancient flute-makers were not governed by set laws, but that each made his instrument according to his own idea. That the tones produced are in false key-relationship is not to be wondered at when we consider the imperfections in their construction; in fact, the flutes are sadly out of tune. What the late John Comfort Fillmore wrote of the Omaha Indian flageolet applies equally to these flutes:

"The imperfections are plainly due to the limitations, not of the Indian's perception, so much as of his scientific knowledge. The flageolet is evidently built 'by guess,' and only remotely approximates to the Indian voice in accuracy of intonation." [1]

Those acquainted with the difficulties that beset the maker of a flute at the present day will see nothing strange in the lack of method in the location of the vents in the flutes of these ancient Peruvians. Mr. Wead remarks:

"In practice these holes never can open so freely to the outside air that the portion of the tube beyond them may be considered as removed (the possibility or necessity of cross-fingering proves this

[1] Omaha Indian Music, Alice C. Fletcher, Appendix, p. 73.

DESCRIPTIONS OF FLUTES REPRESENTED ON PLATE V.

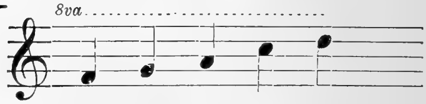
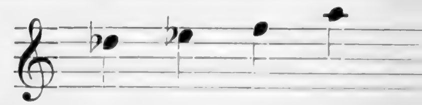
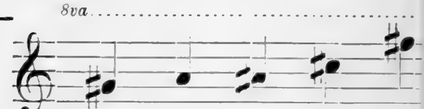
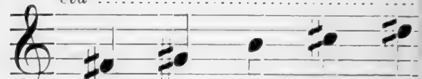
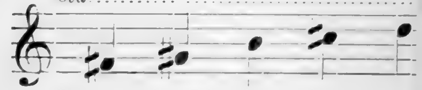
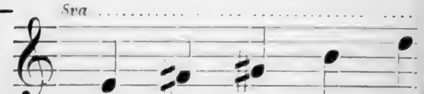
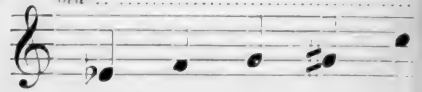
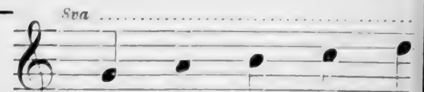
Figure.	Museum No.	Length in inches.	Material.	Scale.
1	B/3852	$15\frac{13}{16}$	Cane	
2	B/8139	$10\frac{1}{8}$	"	
3	B/8138	$9\frac{7}{8}$	"	
4	B/3509	$3\frac{7}{16}$	Bone	
5	B/382	4	"	
6	B/505^{B}	$4\frac{3}{8}$	"	
7	B/3848	5	"	
8	B/3846	$4\frac{9}{16}$	"	
9	B/3847	$4\frac{9}{16}$	"	
10	B/618	$6\frac{1}{4}$	"	
11	B/7945	$5\frac{1}{4}$	"	
12	B/7951	$7\frac{1}{8}$	"	

Figure.	Museum No.	Length in inches.	Material.	Scale.
13	$\frac{B}{8013}$	3	Gourd	
14	$\frac{B}{4929}$	$6\frac{1}{8}$	Bone	
15	$\frac{B}{2648^{A}}$	$6\frac{7}{8}$	"	
16	$\frac{B}{2648^{B}}$	8	"	
17	$\frac{B}{7944}$	$6\frac{3}{4}$	"	
18	$\frac{B}{7954}$	5	"	
19	$\frac{B}{7955}$	$4\frac{1}{2}$	"	
20	$\frac{B}{7948}$	$4\frac{1}{4}$	"	
21	$\frac{B}{619}$	4	"	
22	$\frac{B}{7949}$	$5\frac{3}{8}$	"	
23	$\frac{B}{505^{A}}$	$4\frac{5}{8}$	"	
24	$\frac{B}{7946}$	6	"	
25	$\frac{B}{505^{C}}$	$5\frac{1}{4}$	"	
26	$\frac{B}{750}$	$5\frac{1}{4}$	"	

to the player), so the proper location and diameter of the holes to produce the notes of our scale of even quality are fixed, not by a simple law, as the frets on the guitar are located, but by laborious experimenting to get a standard instrument which is then reproduced with Chinese fidelity." [1]

The question arises, Were the intervals produced on these flutes satisfactory to the Indian? That the first attempt was not so in very many cases, we know from the indisputable evidence of his work. Fig. 4 of Plate V shows the under side of a flute. It will be seen that the original thumb hole has been closed (by a stopper made of gourd) and another perforated above it. No. 7 has had four of the six original holes plugged and others bored near them,—only traces of the gourd plugs remaining. No. 17 shows plainly the plug in the original hole, and the vent which was afterward made above it. No. 19 shows two sets of holes. Of the plugs, only traces remain; but the one in the under side (thumb hole) is still in as perfect condition as those to be seen in figs. 17 and 21. In No. 20 they have entirely disappeared. The scales of the twenty-six flutes shown on Plate V are given on pages 18 and 19. They have been carefully determined in conformity with the international pitch: vibration-number $a^1 = 435$.

Many of the tones produced from these instruments only approximate, in pitch, to some one of the notes of our familiar twelve-tone piano scale. In many instances the variation amounts to nearly a quarter of a tone. Considering the age and condition of these flutes, it is safe to say that in some cases the scales given here are incomplete, and this applies particularly to those made of cane.

No. 14 of this set appears much longer than it really is,—the bird figures being carved on a prolongation of one side of the bone, below the tube.

Nos. 4, 11 and 12, represented on Plate IV, may be classed with the flutes. No. 12 is made from a shell (*Fasciolaria princeps*, Sowb.). It has two vents: one perforated through the top of the spire, the other in its side. No. 4 is an imitation of a shell in terra cotta. It is decorated with a human face and

[1] Contrib. to the Hist. of Musical Scales, Rep. U. S. Nat. Mus., 1900, p. 426.

PLATE IV

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geometrical designs, which are not shown in the illustration. The scales of these flutes are given below:

No. 11, also of terra cotta, is broken and the scale cannot be ascertained. These instruments are sounded by the breath impinging on the sharp edge of the outer lip of the shell.

Resonator Whistle

Whistles of the resonator class have a wide distribution and have been found in different sections of Peru. They are usually made of terra cotta, but sometimes of other materials. The kind most commonly met with emit but one or two tones and generally go by the name of "signal whistles" or "bird-calls." The resonator type reached its highest form of development in Chiriqui and parts of Central America, where they commonly took the human form or that of some well-known animal or bird, and in most cases the grotesque element predominated in the representation. The openings (vents) to the air chamber in the body of these instruments vary in number, but seldom exceed four. On Plate IV, figure 13 shows an instrument of this class. This specimen is one and three-eighths inches high, and measures two and three-quarters inches from the nose to the tip of the tail. Its two vents are on the same side, yielding the following scale:

No. 15, on the same plate, is of wood and has one vent. Its tones are:

No. 6, on Plate III, and Nos. 8, 10, and 14 on Plate IV, are without vents and have but one note each.

Whymper, who gives an excellent account of the Incan remains in Ecuador, figures three of these whistles grotesquely resembling the human form. He has this to say of them:

> "Then there are the musical pottery whistles, delightfully ugly things, which are sometimes more useful to carry than letters of introduction. Simple airs can be got out of them, and on the homeward journey my people lightened the way by playing on these primitive instruments." [1]

GOLD ORNAMENT FROM ICA, PERU. $\frac{1}{1}$

Trumpet

The trumpet in its various forms is undoubtedly one of the most ancient of wind instruments, and its distribution in prehistoric times was all but universal. Two forms of this instrument were common in Peru: the conch and a trumpet of terra cotta. Both of these forms are shown in the accompanying figure.

This illustration shows the ornamentation on one side of a gold ornament found in a prehistoric grave at Ica, Peru. It is double-convex in form, consisting of two thin, concavo-convex pieces which are not joined by solder, as is sometimes the case in ornaments of this kind, but are held together by the edges of one of the pieces being turned tightly over the other. The figures are in *repoussé* work.

Fig. 1 of Plate III represents a remarkably fine specimen of the shell trumpet. It has a copper mouth-piece, and is ornamented with an engraved figure of a warrior. The shell is a *Strombus galeatus*, Swains. Unfortunately the mouth-piece

[1] Travels amongst the Great Andes of the Equator, p. 281.

is so badly corroded that the scale of the instrument cannot be ascertained. Fig. 2, on the same plate, is of a trumpet of terra cotta, and is one of several in the collection in which the shell form has been reproduced in clay. It would seem that this was frequently done when shells could not be obtained. This specimen is in perfect condition. Its scale is as follows:

The lowest or fundamental tone is produced on the open instrument; the next step above in the scale, by introducing the hand a short distance into the opening of the "shell." For the next higher note the hand is pushed still farther into the cavity, and so on until the highest tone of the instrument is reached. In the older natural or French horn, the so-called stopped tones are obtained in much the same way.

Fig. 9 of Plate IV represents a clay trumpet similar to that represented on the gold ornament from Ica figured on page 24; the only difference is the shape of the "bell," which in the latter takes the form of an animal's head. Besides its fundamental tone (B), only its octave can be produced. The other harmonics or overtones, on account of the material and its faulty construction, are absent. Nos. 5 and 6, on the same plate, are trumpets of wood. The mouth-pieces are shallow and cup-shaped, as in No. 9, just described. No. 6 is badly cracked; but No. 5 is entire, and the following tones can be produced from it:

The trumpet is frequently mentioned in the early accounts of Peru. Garcilasso, giving an account of the battle between the army of the Inca Viracocha and the Chancas, says:

"Both armies remained the whole night upon their guard with

sentinels set on each side; and in the morning, by break of day the squadrons arming themselves, with great noise and shouts, with sounds of trumpets, and timbrels, and cornets, they began the onset." [1]

Alonso de Ovalle remarks:

"The sound of the drum and trumpet is only to show them the necessity of their meeting in arms." [2]

Prescott tells us that at the siege of Cuzco (1536)

"The Spaniards were roused by the hideous clamor of conch, trumpet and atabal, mingled with fierce war-cries of the barbarians." [3]

Double Whistling Jar

Fig. 3 of Plate IV shows a double musical water bottle. It consists of two pottery vessels connected near the bottom in such a way that water passes freely from one to the other. Near the top of the first or front jar (usually surmounted by a human or some animal figure) is the opening of the whistle. When the jars have been partly filled and are swung backward and forward, a series of whistling sounds is produced. As the vessel swings forward and upward, the water is lowered in the first jar and raised in the other; in the backward motion it rushes back into the first, forcing the air out through the whistle. It has often been said that the sound emitted by these jars resembles the cry of the animal represented on the vessel. A careful examination of fifty-five of these whistling jars leads to the conclusion that this is the result of a lively imagination—that they are whistles pure and simple.

Fig. 4 of Plate III shows a nondescript instrument made of terra cotta. The tone is produced by blowing into either of the two holes in exactly the same manner that the trumpet is sounded. The lips, in both cases, act as reeds, causing the vibration of the air within the instrument.

[1] Royal Commentaries of Peru, Ed. Rycaut, Part I, Book V, Chap. XVIII.
[2] Historical Relation of Chile, Pinkerton, Vol. XIV, p. 122.
[3] Conquest of Peru. Vol. II, p. 47.

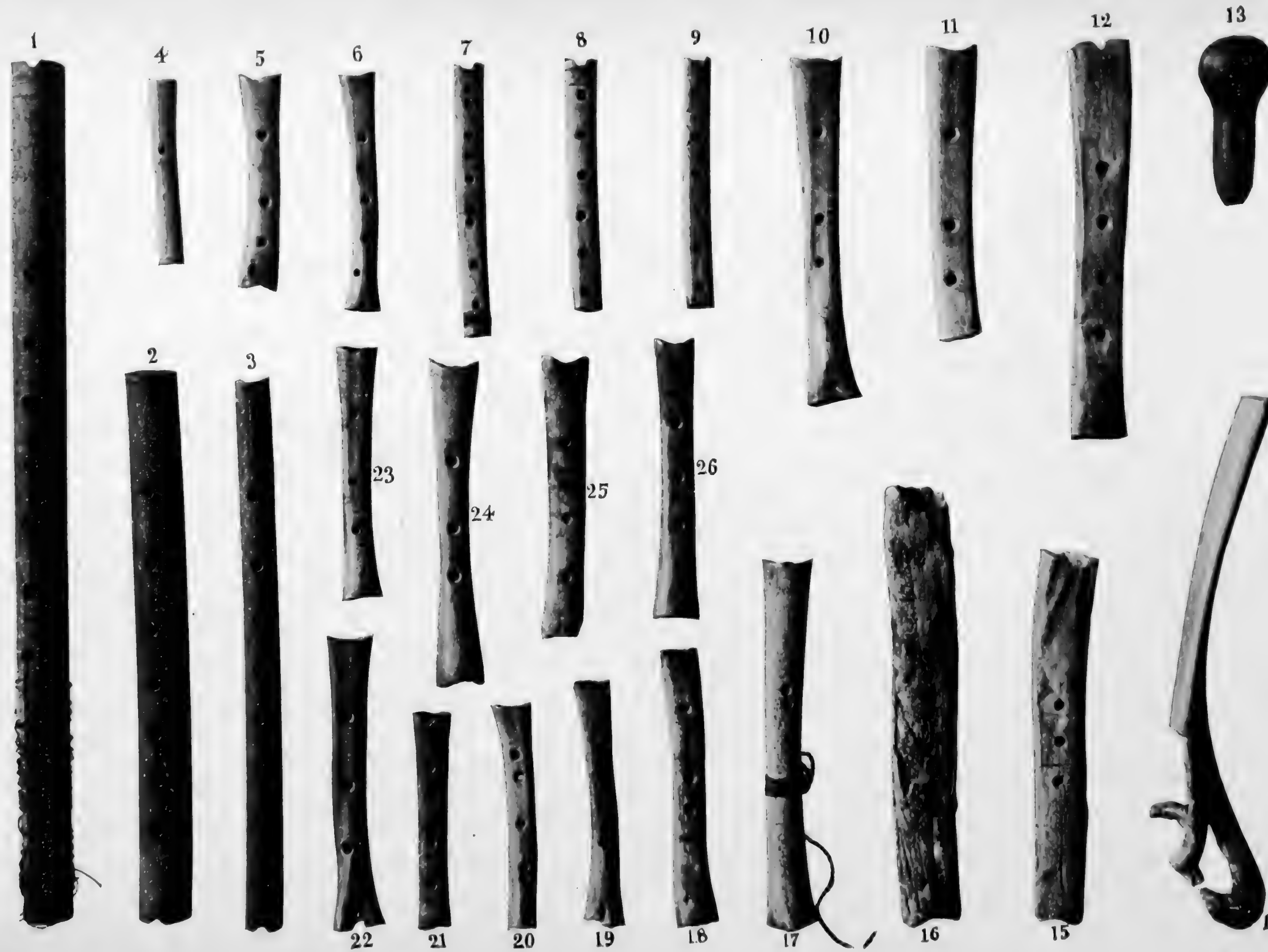

PLATE V

27

Cornet

Cornets were used by the Inca's army at the siege of Cuzco. Formerly this name was given to a rude reed instrument of the oboe family, and it is probable that it was similar to those still used in a number of tribes in the Amazon region: a piece of cane from two to five feet long, with one end closed by some gummy substance, through which is passed a split quill which forms the "reed." Herrera tells us that Orellana, on his voyage down the Amazon (1540–1541), was pursued by 130 canoes containing 8000 Indians, and that the noise of their drums, cornets and shouting was a thing frightful to hear.[1]

STRINGED INSTRUMENTS.

A NUMBER of modern writers have stated that the *tinya*, a kind of guitar with five strings, was known to the Peruvians in pre-Spanish times. This seems as improbable as Rankin's story of fiddlers being attached to the court of Montezuma.[2] Garcilasso de la Vega, in his chapter entitled "Of the Geometry, Geography, Arithmetick and Musick known to the Indians," gives no account of any stringed instrument.[3] There is scarcely a chapter in the "Cronica del Peru" of Cieza de Leon that does not contain mention of some musical instrument, but we find no hint of instruments of this class. The Peruvians themselves, as we have seen, left behind them many of their instruments and numerous representations of them on their pottery vessels and metal ornaments; but among them all, not one belonging to the lyre type can be found. Professor O. T. Mason says:

> "After looking over the musical collection of the United States National Museum and such literature as has been collected by the Bureau of American Ethnology, I have come to the conclusion that stringed musical instruments were not known to any of the aborigines of the Western Hemisphere before Columbus."[4]

[1] Voyage of Francisco de Orellana, Ed. Hakluyt, p. 29.
[2] Conquest of Peru and Mexico by the Mongols, p. 344.
[3] Royal Commentaries of Peru, Ed. Rycaut, Part I, Book II, Chap. XIV.
[4] American Anthropologist, Vol. X, No. 11, 1897.

Professor E. S. Morse agrees with Dr. Mason that there is no evidence of a pre-Columbian stringed device. [1]

I believe that no claim has as yet been made for the existence of the musical bow in Peru; and what Dr. Henry Balfour says of this most primitive of stringed instruments is very important, as showing with what caution the evidence should be considered before pronouncing any instrument to be of pre-Spanish origin:

"In viewing the various types of musical bow to be found in the New World, I must say that I feel that the case of the claims of this instrument to be regarded as indigenous (pre-Columbian) in the Americas can only as yet be dismissed with the verdict of *not proven*. I can find no absolutely convincing evidence to prove the case, and in view of the certainty of many varieties having been introduced by the immigrants from Africa, it will require very strong evidence to establish the claim." [2]

Although not conclusive, such evidence as we have at the present time is against the existence of any form of stringed instrument in Peru before the coming of the Spaniards.

CONCLUSION.

Undoubtedly the most important instruments were the drum, the various kinds of flutes and the Pan-pipe. Early writers frequently speak of the Indians dancing to the music of the pipe and tabor. The ancient potters have left us representations of these scenes on their water vessels (Plate I, figs. 1 and 2). These dances appear to have remained unchanged in 1649 when Alonso de Ovalle wrote this quaint account:

"Their way of dancing is with little jumps, and a step or two, not rising much from the ground, and without any capers such as the Spanish use; they dance all together in a ring." [3]

Of the music of the Incas we know nothing. A number of songs have been recorded which have been known to the Indians for generations, and believed by them to have been handed down unchanged, but their authenticity is, of course, doubtful—even

[1] Appleton's Popular Science Monthly, March, 1899.
[2] The Natural History of the Musical Bow, pp. 50–51.
[3] Historical Relation of Chile, Pinkerton, Vol. XIV, p. 117.

the source from which they came being uncertain. Negroes were introduced early into all the Spanish colonies, and doubtless many of their tunes were adopted by the Indians. Garcilasso tells us that when he left Peru in 1560 there were then five Indians residing in Cuzco who were great masters on the flute, and could play readily, by book, any tune that was laid before them.[1] In view of these conditions, we may well be sceptical concerning the claims of any music said to be pre-Spanish.

We now come to that much vexed question, What musical scale was known to the ancient Peruvians? In the absence of any authentic music we must look to their instruments as the only source of information. It has been believed commonly that they employed the five-toned or pentatonic scale, so widely used in the primitive music of various peoples, which one of our most eminent musical scholars and critics insists "represents a stage in musical development and is neither a racial nor geographical indication."[2] In this scale the step of a semitone is avoided by omitting the fourth and seventh degrees in major and the second and sixth in minor.

Many of the scales given in this paper seem to indicate the use of this five-toned scale, but there are some puzzling exceptions. Hitherto but few scales of Peruvian instruments have been published. When a sufficient number has been collected, it may be possible to determine the intervals of the Peruvian scale.

[1] Royal Commentaries of Peru, Ed. Rycaut, Part I, Book II, Chap. XIV.
[2] H. E. Krehbiel in *New York Tribune*, Sept. 8, 1901.

THE AMERICAN MUSEUM JOURNAL

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Maintains scientific publications:
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Funds to make additional groups similar to those in the Bird, Mammal and Ethnology Halls.
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Means for collecting fossils and geological specimens.

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The Knickerbocker Press, New York

AMERICAN MUSEUM OF NATURAL HISTORY

The Collection of Fossil Vertebrates

BY

W. D. Matthew, Ph.D.

Associate Curator of Vertebrate Palæontology

SUPPLEMENT TO AMERICAN MUSEUM JOURNAL

VOL. III, No. 5, OCTOBER, 1903

Guide Leaflet No. 12

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The Collection of Fossil Vertebrates

A Guide Leaflet to the Exhibition Halls
of
Vertebrate Palæontology
in the
American Museum of Natural History

By
W. D. MATTHEW, Ph.D.
Associate Curator, Department of Vertebrate Palæontology

PUBLISHED BY THE MUSEUM
AS SUPPLEMENT TO THE AMERICAN MUSEUM JOURNAL
VOL. III, No. 5, OCTOBER, 1903
Guide Leaflet No. 12

PREFATORY NOTE

THE COLLECTION of fossil vertebrates belonging to the American Museum of Natural History comprises the extensive material collected by the late Professor E. D. Cope chiefly between 1870 and 1890 and the much larger collections made by the expeditions which have been sent out by the Museum every year, beginning with 1891. Most of the Museum expeditions have worked in the western States.

From the beginning of the department in 1891 the collection and exhibition of these fossils have been under the direction of Professor Henry Fairfield Osborn, the curator. From 1891 to 1898, inclusive, the exploring parties in the field were under the immediate supervision of Dr. J. L. Wortman. Since that time Messrs. Matthew, Granger, Brown and Gidley have been in charge of the field work.

The funds necessary for sending out the expeditions and for the purchase of the Cope Collection have been furnished chiefly by President Jesup and Messrs. Osborn, Whitney and Constable. The exhibit illustrating the evolution of the Horse is mostly the gift of Mr. William C. Whitney.

EDITOR.

HALL OF FOSSIL MAMMALS

THE COLLECTION OF FOSSIL VERTEBRATES.

By W. D. Matthew, Ph.D.,

Associate Curator, Department of Vertebrate Palæontology.

TABLE OF CONTENTS.

Introduction.

When we dig beneath the present surface of the ground we sometimes find remains of ancient cities, dwellings, bones of men and animals, buried many centuries ago under accumulations of débris, deposits of river mud or drifted sand. From these have been gleaned many facts concerning the early history of mankind of which there is no written chronicle. From the study of these facts the science of Archæology has arisen, the science which deals with the early history of mankind, with the evolution of civilization.

What Fossils Are.

Most of the lower animals of which the archæologist finds traces are like those now living, although a few have become extinct. But in those more ancient deposits which are now consolidated into clays, sandstones etc., indica-

tions of man are not found, and the remains of lower animals which they contain are unlike any now living—the more unlike as the rock is more ancient. These remains are called *fossils.* They consist only of the hard parts of animals (bones, shells, spines etc.). The soft parts are never preserved, and only very rarely is some trace of skin or hair, horns or hoofs, to be distinguished. As in the course of ages the mud or sand in which they are buried changes to rock, so little by little the fossils have been changed by heat, pressure and especially by the slow infiltration of mineralized waters into brittle, stony material, while retaining their outward form and usually their peculiar structure. But mud and clay, in changing into rock, settle down and contract considerably, and the fossils are flattened out correspondingly, sometimes to such a degree, in the case of a rock which has once been a soft, oozy mud, that they suggest rather a picture or a bas-relief than the original form of the animal. The fossil skeletons of marine reptiles and fishes on the walls of the corridor hall and in the case opposite the elevator have been flattened out in this manner, especially the Ichthyosaur skeletons.

Science of Palæontology.

From fossils we can interpret the history of the world of life during the long ages before man appeared. The science which deals with the ancient history and evolution of the animal kingdom is Palæontology (*παλάιος,* ancient, *ὄντα,* living beings, -*λογία,* science). It tells us of a long period of time before Man appeared, probably millions of years, during which Mammals of great size and unfamiliar form were the dominant animals—of a yet longer era before that, during which huge Reptiles were rulers of earth, sea and air—and of other still more ancient periods during which Amphibians, Fish and Invertebrate Animals held sway in turn. Vertebrate Palæontology deals only with the higher classes of fossil animals, the Vertebrata, or those that have backbones (fish, amphibians, reptiles, birds and mammals).

Geological Time.

Earth-history or geological time has been divided into many parts according to the evidence furnished by the rocks and the fossils contained therein. The principal subdivisions are shown in the accompanying table:

FOSSIL SKELETONS IN THE ROCK

This slab of soft chalky clay contains five skeletons of an extinct animal. One is an old male, the other four are young

GEOLOGICAL ERAS, PERIODS AND AGES.

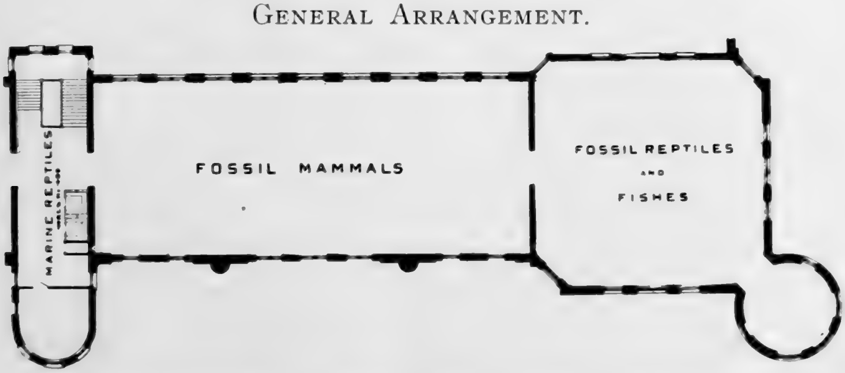
Eras.	Periods.	Ages.
Cenozoic	Quaternary	Age of Man, 50,000 years
	Tertiary	Age of Mammals, 3,000,000 years
Mesozoic	Cretaceous	Age of Reptiles, 7,000,000 years
	Jurassic	
	Triassic	
Palæozoic	Permian	Age of Amphibians and Coal Plants, 5,000,000 years
	Carboniferous	
	Devonian	Age of Fishes, 2,000,000 years
	Silurian	Age of Invertebrates, 10,000,000 years
	Cambrian	
Eozoic	Algonkian	(No fossils)
	Archæan	

The estimates in years of the geological periods given in this table, which is arranged in descending order from the most recent to the most ancient time, must be understood to be merely very rough approximations. There is no known method of finding any exact equivalent in years of any geological period, although the relative length of each to each is much more nearly known. The estimates given herewith are based on the careful study of the subject made by C. D. Walcott, Director of the U. S. Geological Survey. In concluding his discussion Dr. Walcott stated his belief that the duration of geological time (the entire period included in this table) might be measured by tens of millions of years, but not by single millions or by hundreds of millions.

To give the visitor a clear idea of these extinct animals, the skeletons usually have been removed entirely from the rock in which they were found and have been mounted as much as possible like skeletons of modern animals. To mount a petrified skeleton in this manner is a very difficult matter, for such skeletons are rarely perfect, and the bone is always very brittle and more or less shattered and crushed out of shape. In the mounted skeleton the missing parts have been restored in tinted plaster, modeled from other individuals or from nearly related animals in which these parts are known. The outlines of the restored parts of bones are marked off with red lines, while entire bones modeled in plaster are marked with a red cross, or with a red circle if supplied from other individuals. All the skeletons are original specimens except the *Megatherium* at the far end of the hall; and all are of extinct animals except a few which are placed with the others for comparison. With each fossil skeleton will be found, besides a descriptive label, a small model and a water-color restoration of the animal, showing its probable appearance during life and indicating its supposed habitat. The transparencies in the windows show the localities where the fossils are found, chiefly in the Bad-lands of the western States.

How Fossil Skeletons are Mounted.

General Arrangement.



The collections are arranged to illustrate the geological history and evolution of the different groups of Vertebrata, especially those of North America. They fill two large halls and a corridor.

General Arrangement of Collections.

East Wing. Hall No. 406. Fossil Mammals.

East Wing. Hall No. 407. Fossil Reptiles, Amphibians and Fishes.

In addition

East Corridor, No. 405 (in which are the elevator and stairways), contains fossil Marine Reptiles and Fishes of the Age of Reptiles.

SKELETON OF THE GREAT MARINE LIZARD IN THE EAST CORRIDOR

THE EAST CORRIDOR. No. 405.

The Preservation of Fossils in the Rocks.

On stepping from the elevator the visitor sees before him a case filled with skulls and skeletons of the marine reptiles and fishes which inhabited the great inland sea that once spread over the center of the North American continent, from Canada to Mexico. The reptiles were of kinds now long extinct, *Plesiosaurs* with long snaky neck, short bulky body with long flippers and stubby tail, and *Mosasaurs* with short neck and longer tail. Some of the fishes were ancestors, collateral or direct, of certain modern fishes, others belonged to groups now extinct. These animals lived and died, their carcasses sank to the bottom of the sea, and were buried in whatever sediment was being deposited there—soft white ooze in the open sea, dark gray or black mud nearer the shores. In the course of ages this ooze or mud settled gradually and consolidated into chalk or shale. Afterwards as the continent rose above the waters and assumed more nearly its present dimensions, the rivers flowing over the broad plains excavated

HUNTING FOR FOSSILS IN THE BAD-LANDS

Members of the American Museum Expedition of 1894 in the Uinta Basin, Utah

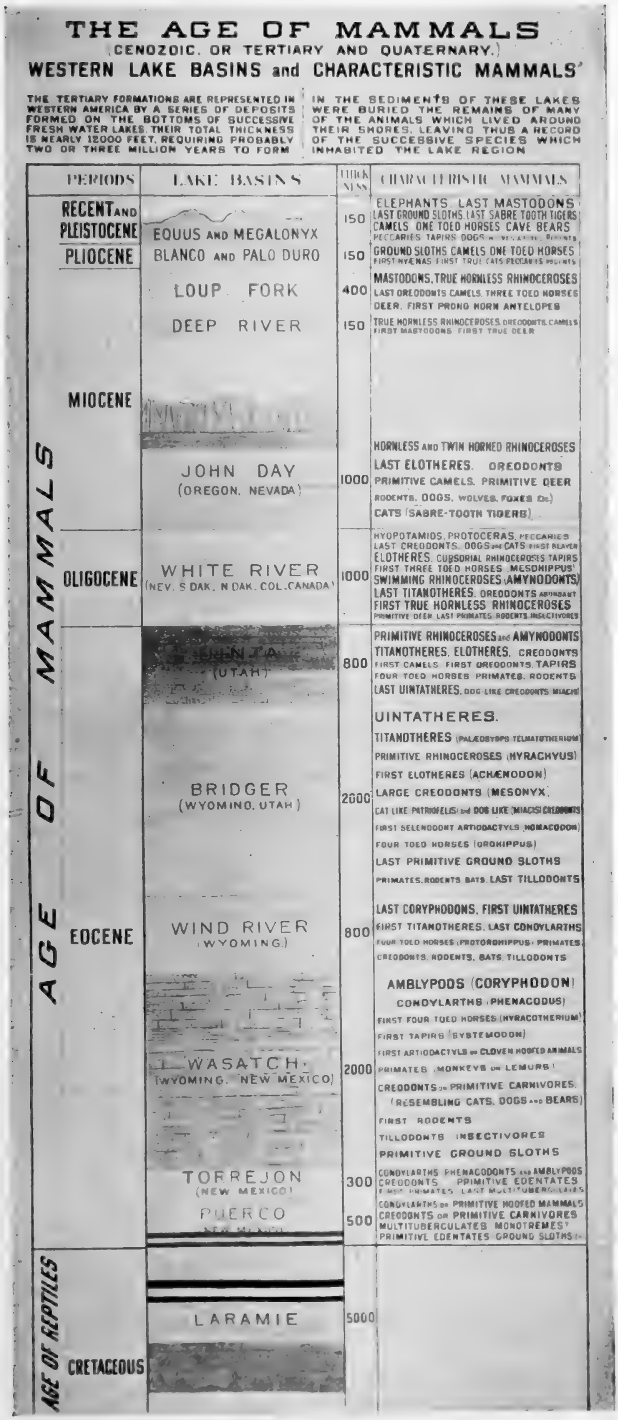
broad shallow valleys in the chalk and shale. In the dry climate **The Finding and Collecting of Fossils.** of the present day the sides of these valleys often are bare rock, carved by wind and the infrequent storm-bursts of rain into the fantastic maze of cliffs and winding cañons known as "bad-lands." Here and there, projecting from an outstanding ledge or trailing in fragments down some crumbling slope, a fossil bone may be seen by the trained eye of the collector as he searches along the rock exposures; and quarrying in around the bone he is sometimes rewarded by a skull, sometimes by a string of vertebræ, occasionally by a whole skeleton, buried in the rock except for such parts of it as have been weathered out and washed away.

To excavate the fossil without damaging the brittle bones, buried as they are in a weak and shattered mass of heavy shale or chalk, is a slow and delicate operation, requiring special methods and considerable care and skill. Then the specimen must be packed, and sent in to the Museum, where the rock is removed and the specimen is prepared for exhibition. When the bones are as much crushed and distorted as those represented in the photograph (page 10) the matrix is removed from one side only, and the specimen is thus placed on exhibition.

Temporarily placed in the bottom of the case is a large Plesiosaur skeleton, only partly removed from the rock. This **Important Specimens in Corridor.** specimen unfortunately lacks the skull. Beside the lower stairway is a Mosasaur skeleton, the finest specimen of its kind ever found, and above it is a large fish skeleton which was found in the same strata in western Kansas. Beside the upper stairway are three skeletons of Ichthyosaurs, another long extinct group of marine reptiles, of fish-like appearance, paralleling the modern Whales among mammals.

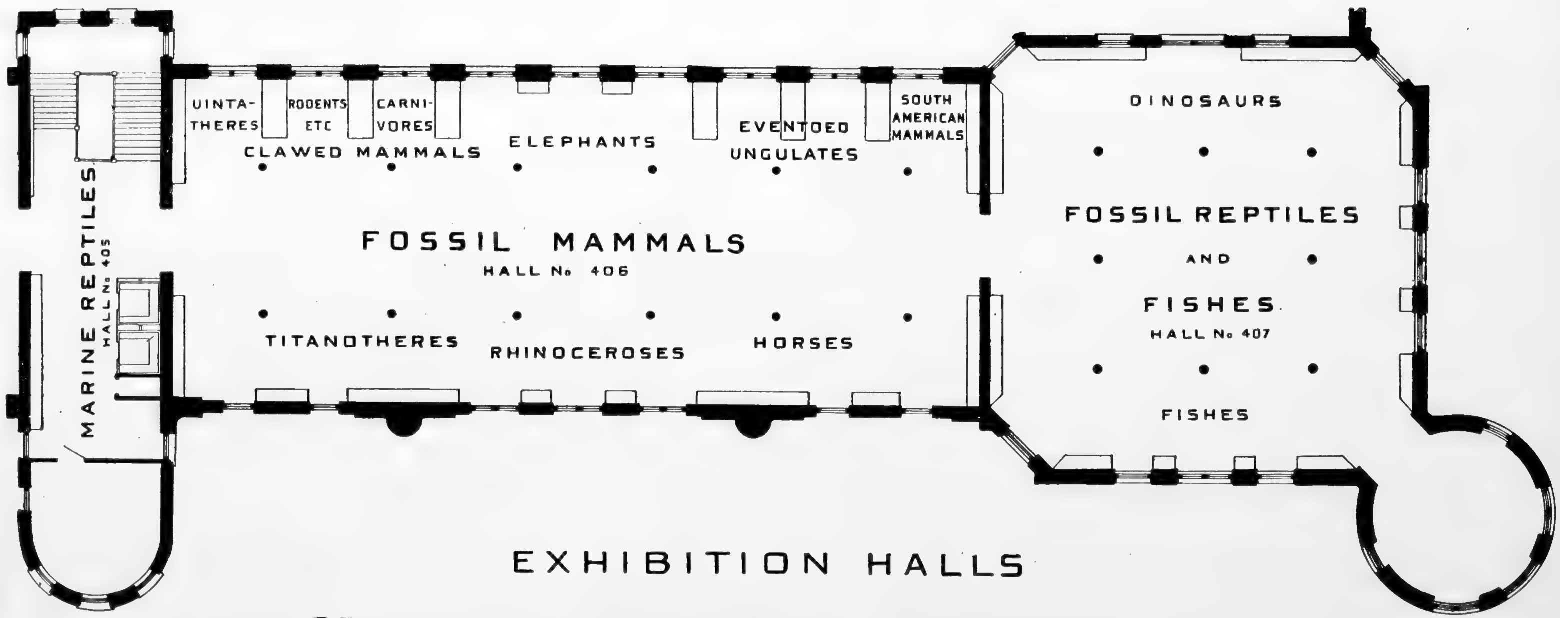
EAST WING. HALL NO. 406. FOSSIL MAMMALS.

The ancestors of our modern quadrupeds are to be found in the East Wing, No. 406, together with many extinct races more **Arrangement of the Fossil Mammals.** or less nearly related to them. All the fossil specimens of each group of mammals are placed together in one alcove, where they have been arranged according to their geological age. Thus all the fossil Horses, direct



DIVISIONS OF THE AGE OF MAMMALS

Characteristic fossil mammals, and the geological formations in which they are found



EXHIBITION HALLS

DEPARTMENT OF VERTEBRATE PALAEONTOLOGY

or collateral ancestors of the modern Horses, Asses and Zebras, are in one alcove, arranged in series from the most ancient to the most recent. The most ancient and structurally primitive groups of mammals come first, the most modern and familiar types come last.

South (Right) Side.		North (Left) Side.	
	TITANOTHERES	AMBLYPODS	Primitive Hoofed Mammals
	Chalicotheres	CONDYLARTHS	
		Monkeys, Bats, Rodents, Insectivores and other Small Primitive Mammals	
		Marsupials	
		CREODONTS	Carnivorous Mammals
		CARNIVORES	
		Seals, Dolphins, Whales, Sirenians etc.	Marine Mammals
Perissodactyls or Odd-Toed Hoofed Mammals	Tapirs	MASTODONS and	Proboscideans
	Lophiodonts	ELEPHANTS	
	RHINOCEROSES	ELOTHERES	Artiodactyls or Even-Toed Hoofed Mammals
		Anthracotheres	
		Pigs and Peccaries	
		OREODONTS	
		CAMELS	
	Palæotheres	DEER etc.	
	HORSES	Litopterna	Fossil Mammals Peculiar to South America.
		Toxodontia	
		Typotheria	
		EDENTATA	

SOUTH (RIGHT) SIDE.

The south side of the hall is entirely devoted to the PERISSODACTYLS or Odd-Toed Hoofed Mammals in which the number of toes (in the hind foot and generally in the forefoot) is either 1, 3 or 5, while in the other main division of hoofed animals, the Artiodactyls, it is either 2 or 4; or more exactly, the axis of symmetry of the foot passes through the central toe in Perissodactyls, while in Artiodactyls it passes between two toes.

South Alcove 1. Titanotheres

The TITANOTHERES come first in the series of Perissodactyla, large animals which suggest rhinoceroses in general proportions, but have a differently shaped head and peculiar teeth. These began as hornless animals of moderate size (Cases 1 and 17) and increased in size and developed large bony horns (Cases 3, 5 and 19) before they

became extinct. The Titanotheres occupy the first of the three main alcoves into which the south side of the hall is divided.

The second alcove is devoted to the RHINOCEROSES, which

RESTORATION OF TITANOTHERIUM, AN EXTINCT HOOFED MAMMAL OF WESTERN AMERICA

The picture shows a bull, a cow and a calf

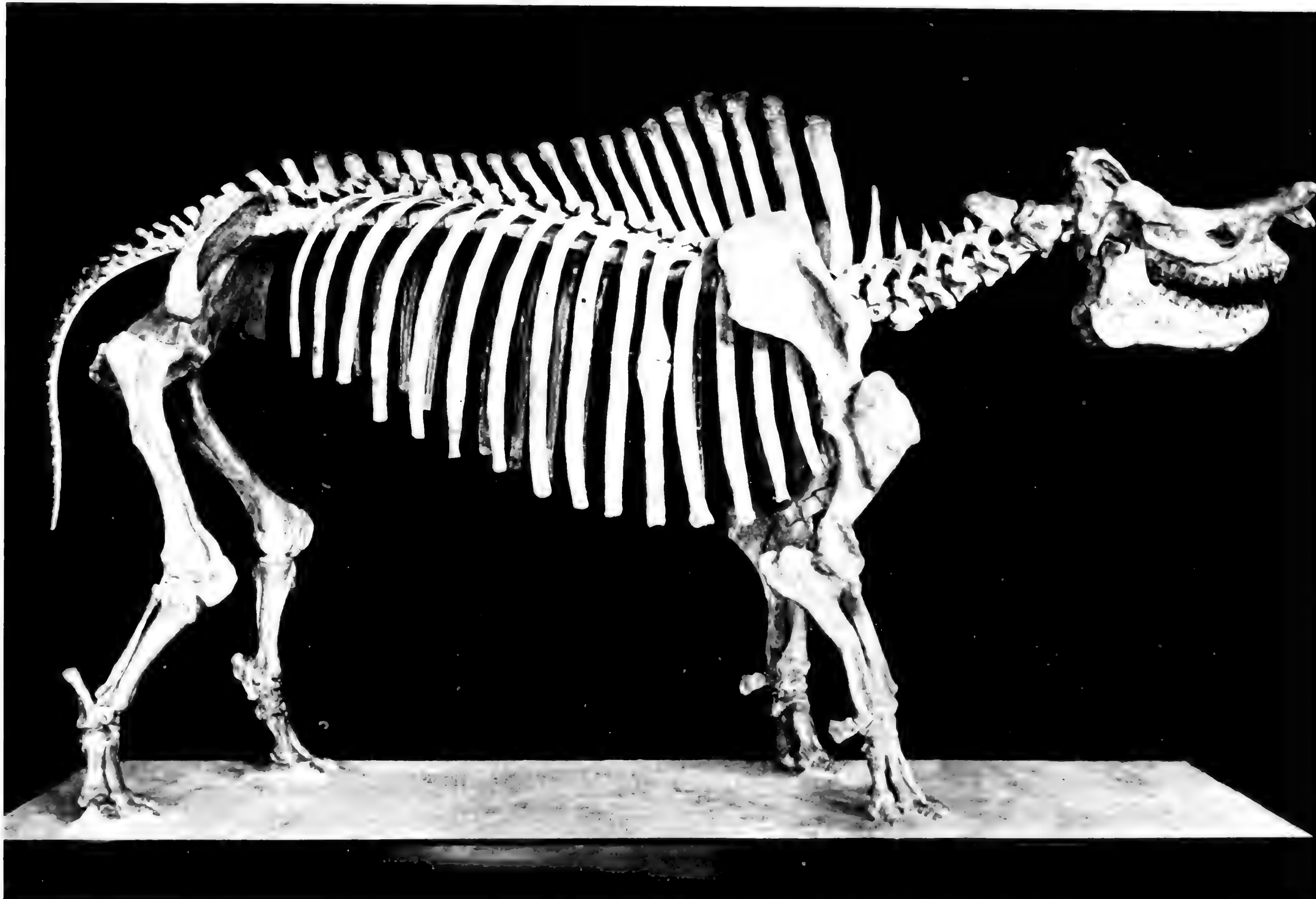
From the original water-color, based on mounted skeleton and skulls in American Museum of Natural History

South Alcove 2. Rhinoceroses.

were very common beasts in North America as well as in the Old World during the Tertiary period. They also began in the Eocene as small hornless animals (*Hyrachyus*, Case 7), but diverged in the Oligocene into cursorial, aquatic and true (terrestrial) Rhinoceroses of which the two former soon became extinct. True Rhinoceroses also became extinct in America by the Pliocene epoch, while in the Old World several of them have survived to the present day.

Third Alcove. HORSES.[1] This fine exhibit is due chiefly to

[1] For more detailed information regarding the evolution of the Horse, see Guide Leaflet No. 7, "The Evolution of the Horse." Published January, 1903.



MOUNTED SKELETON OF THE TITANOTHERE, FROM THE BIG BAD-LANDS OF SOUTH DAKOTA

the liberality of Mr. Wm. C. Whitney. The Evolution of the Horse is illustrated by a series of feet and skulls, and of complete skeletons, from the little Four-Toed Horse of the Lower Eocene to the different varieties of the modern animal. The construction of the modern Horse, structure of the bones, the way in which the teeth grow, characters of the different races of domestic Horse and of the different wild species are shown in the end case (Case 15).

South Alcove 3. Horses.

NORTH (LEFT) SIDE.

First come the AMBLYPODS and CONDYLARTHS. These groups of Primitive Hoofed Mammals are first found in the lowest Eocene strata, at the very beginning of the Age of Mammals and they became extinct before the end of the Eocene epoch. Like so many other races the Amblypods begin with small hornless animals (*Pantolambda*) and finally develop into huge elephantine beasts (*Uintatherium*) with six horns on the skull, and great sabre-like tusks. The Condylarths were more slender types, fitted for running. The best known among them is *Phenacodus*, which is considered to represent very nearly the prototype of the hoofed mammals, although it was not the direct ancestor of the later groups.

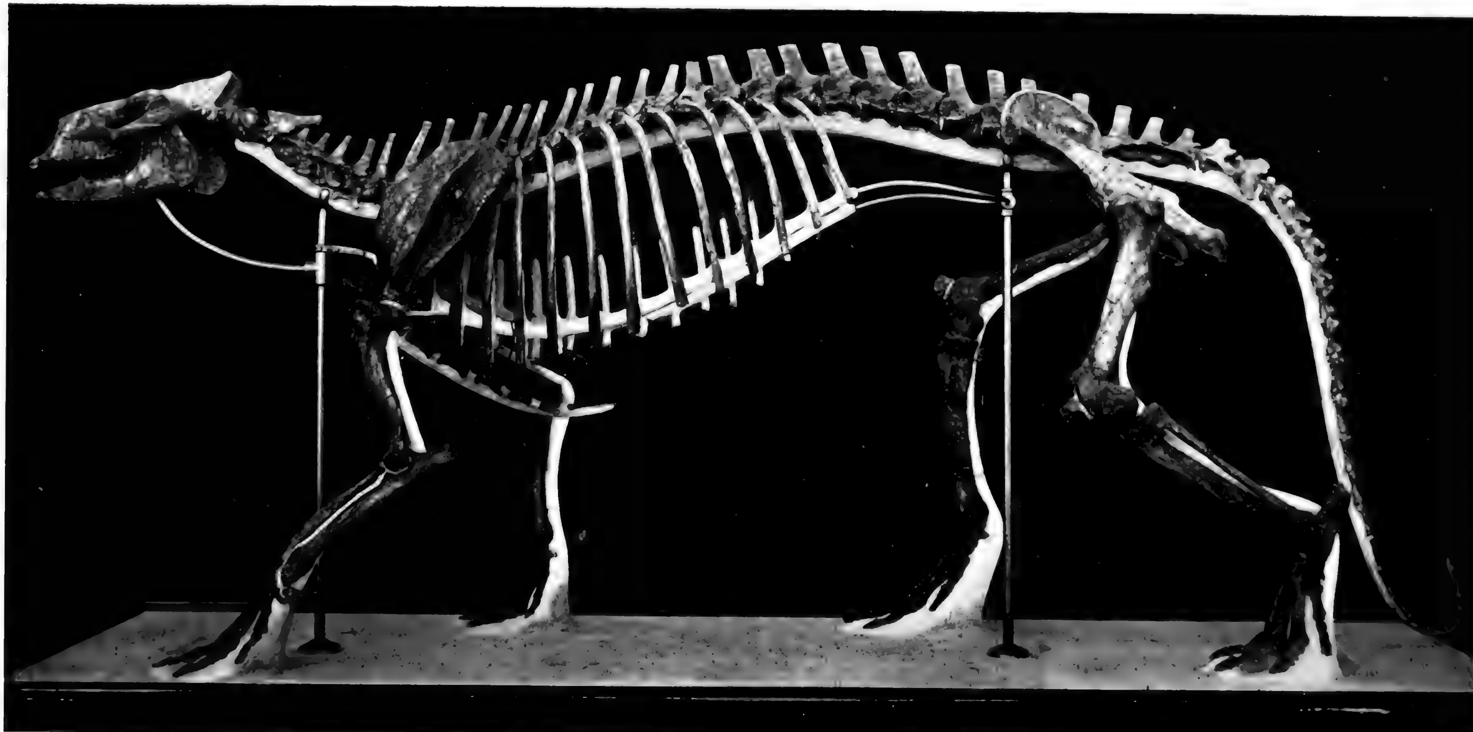
North Alcove 1. Amblypods, etc.

The second alcove is devoted to Rodents, Insectivores, Bats, Marsupials and other groups of small mammals, among which are the ancestors of the Monkeys and Lemurs and collateral ancestors of Man. Most of these remains are small and incomplete. Here are also some very fragmentary remains of ancient and primitive mammals which represent all that we know of the evolution of the mammalia during the Age of Reptiles, before the Age of Mammals began. These teeth and jaws are of interest because they are the oldest of mammals, from some of which are probably descended all the later mammal groups.

North Alcove 2. Small Mammals.

In the third alcove are the Carnivorous Mammals, on one side the CREODONTS or Primitive Carnivora, on the other the True CARNIVORA (Dogs, Cats, Bears, Martens etc.), represented by a number of finely preserved mounted skeletons, and a large series of skulls, together with other specimens.

North Alcove 3. Carnivora.



MOUNTED SKELETON OF PHENACODUS IN NORTH ALCOVE 2

This animal, although not a direct ancestor, represents the prototype of the hoofed mammals

Most remarkable among extinct carnivora are the Sabre Tooth Tigers, in which the upper canine teeth are enlarged into long, curving, flattened, serrate fangs, most terrible weapons, effective no doubt against the thick hides of the primitive pachyderms.

North Alcove 4. Marine Mammals.

The fourth alcove is very narrow. In it are placed a few remains of fossil marine mammals: Seals, Cetaceans and Sirenians. These groups are very imperfectly known as fossils.

North Alcove 5. Proboscidea.

The fossil ELEPHANTS and Mastodons are in the next broad alcove, about the middle of the hall. The evolution of these animals is shown by a series of skulls. The Mastodon skeleton and the skull and fore-limb of the Imperial Mammoth from Texas, and tusk of the Siberian (Hairy) Mammoth are noteworthy specimens.

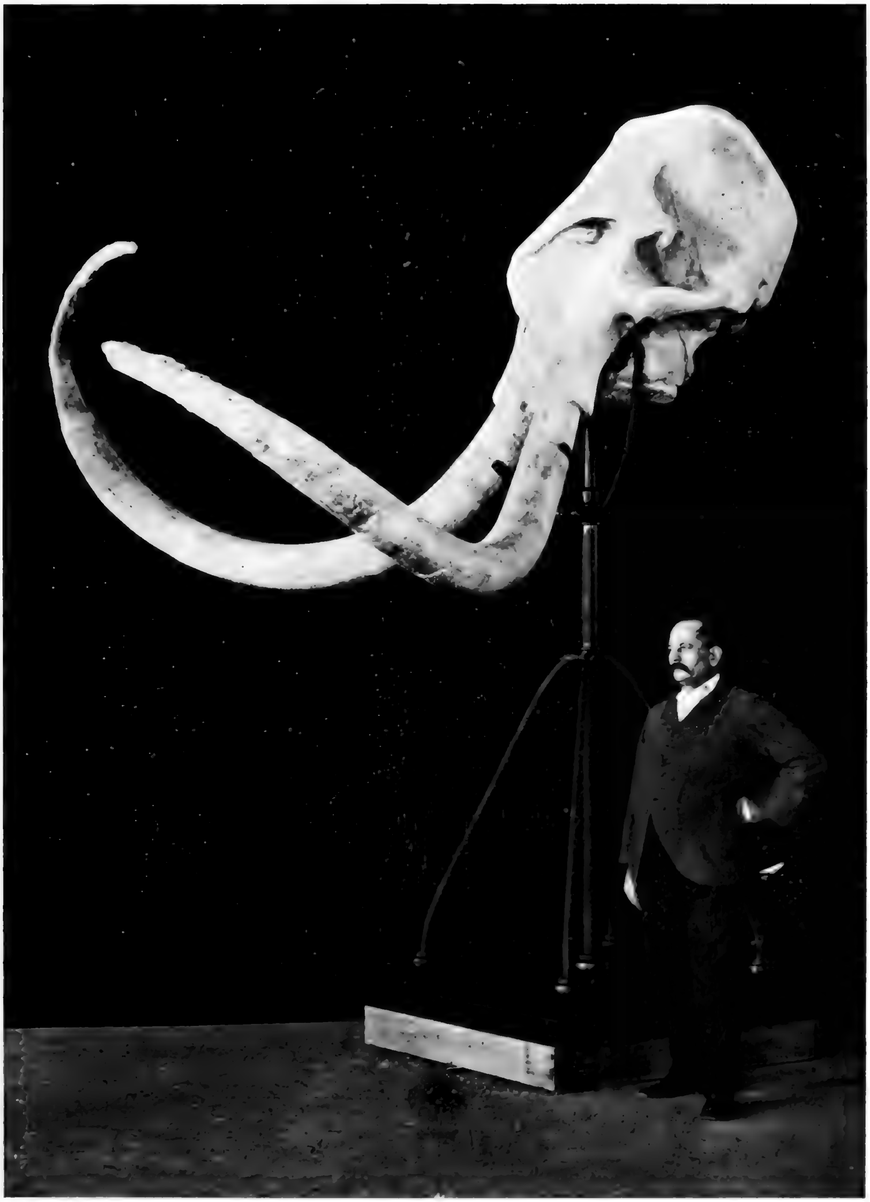
North Alcove 6. Elotheres.

North Alcove 7. Pigs, Peccaries, Oreodonts, Camels.

Beyond the Elephants are the ARTIODACTYLS or Cloven-Hoofed Mammals. They divide into two groups, typified by the Pigs and the Ruminants, the latter including the greater part of modern hoofed mammals, but by no means proportionally common as fossils. First among the fossil artiodactyls are the Elotheres, an extinct race of large animals distantly related to Pigs and Hippopotami. Next are the fossil Peccaries; then the Oreodonts, pig-like animals with the teeth of ruminants, very abundant in America during the middle and later Tertiary, but extinct before the Pliocene epoch. Then come the Camels, which although now found only in Asia and South America, originated in North America, and afterwards migrated to these other continents and became extinct in their native land. The evolution of these animals is shown by a series of stages only less complete than the stages in the evolution of the Horse.

North Alcove 8. Deer, Antelope etc.

The higher ruminants (Deer, Antelope, Sheep and Cattle) are rather poorly represented in the collections. The Great Irish Deer is the most striking among the extinct species; attention is also called to the mounted skeletons of *Protoceras*, a deer-like primitive ruminant of the Oligocene epoch, and of *Merycodus*, a graceful little animal of the Miocene epoch intermediate between the Deer and the Prong-horn Antelope.



SKULL AND TUSKS OF THE IMPERIAL MAMMOTH
From a photograph of the specimen on exhibition in the American Museum of Natural History

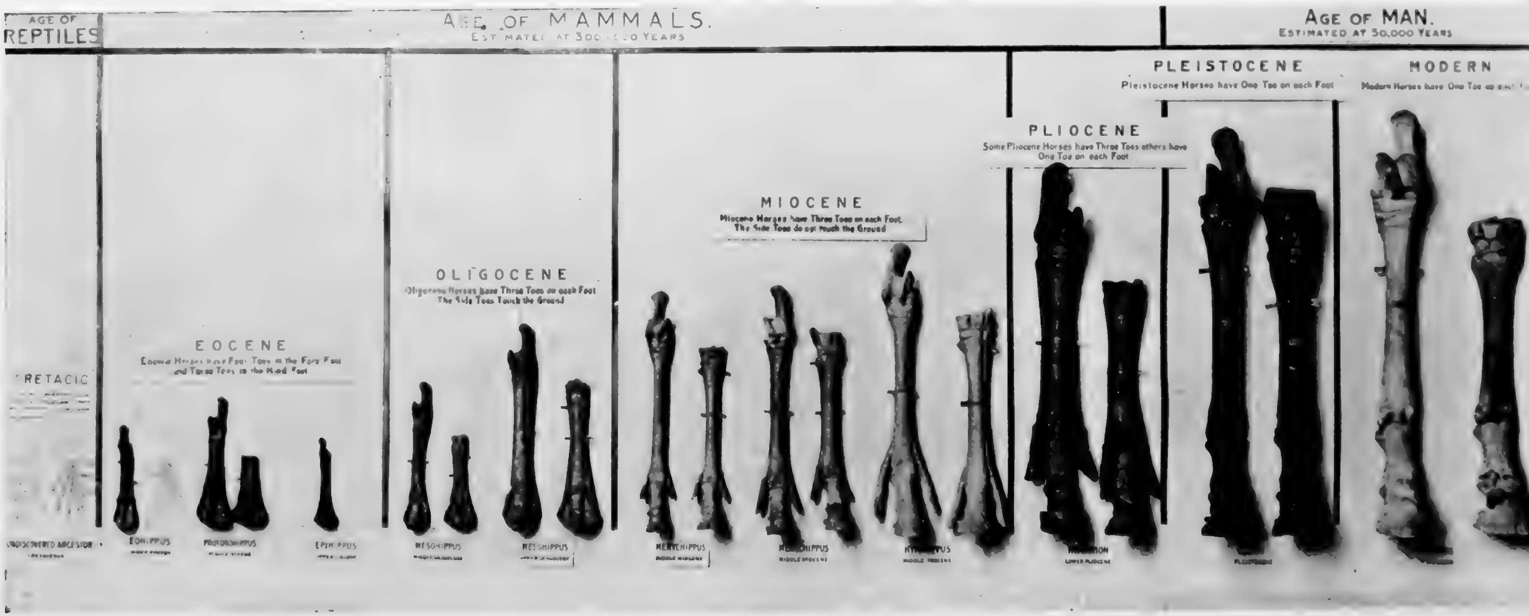
The northeast corner of the hall is devoted to a number of peculiar groups of SOUTH AMERICAN FOSSIL MAMMALS, almost all extinct. During the Age of Mammals the two great northern continental areas were joined together from time to time, so that there has been an occasional interchange of animals and plants among them, the races developed in one continent spreading to the other. The animals of North America therefore, although mostly of species distinct from those of Europe and Asia, are more or less nearly related to them. But during most of the Age of Mammals South America was an island continent, as Australia is still; and its extinct animals are as peculiar and as different from those of the rest of the world as are the living animals of Australia different from those of other continents. It is by no means certain where these animals originally came from, but there is much evidence to show that both South America and Australia were peopled from an Antarctic continent, now sunk beneath the ocean or buried in the ice fields of the more frigid climate of modern times.

North Alcove 9. South American Fossil Mammals.

Of these peculiar South American groups the most extraordinary are the Edentates, including the Sloths, Armadillos and Anteaters which still survive, and the huge MEGATHERIA or Ground-Sloths and GLYPTODONTS or Tortoise-Armadillos which have become extinct. Others were the TOXODONTS, TYPOTHERES, ASTRAPOTHERES and LITOPTERNA, peculiar groups of hoofed animals all now extinct. Some of the Litopterna lost their side toes and evolved into a one-toed race curiously like the horses of the northern hemisphere, although not at all related to them; this is one of the most interesting examples of the parallel adaptation of two different races of animals to similar conditions of life; the horses in the plains and prairies of the north, the litopterna in the pampas of the southern continent.

The best example of the evolution of a race of animals is shown in the southeastern corner of the hall. Here is exhibited the *Ancestry of the Horse*, the specimens from successive geological strata showing how the modern Horse has descended from diminutive ancestors with four toes on each forefoot and three on each hind foot, and with teeth and other

Instances of Evolution.



EVOLUTION OF THE HORSE. FEET

parts of the skeleton different from those of their modern representatives.

Almost equally complete, although less familiar, is the series illustrating the *Ancestry of the Camel*, which may be found on the north side of the hall near the east end. These animals, like the Horses, evolved from small and primitive ancestors to large and highly specialized descendants, and then became extinct in their former home, the broad and arid plains of western America, before the advent of civilized man, but survived to modern times in other parts of the world (Asia, Africa and South America). Less complete series are the skulls and skeletons illustrating the ancestors of Titanotheres and the ancestors of Rhinoceroses. These are ranged along the south side of the hall beginning at the entrance.

All these series have been placed according to geological age. The most ancient specimens, found in the lowest rock-strata, and hence representing the earliest stage of evolution, are placed first in the series. The most recent ones, found in the uppermost rock-strata, and representing the final stage of evolution of the race, are placed last. Arranging the species of a race from each stratum in the order of the age of the strata, we find that they show a regularly progressive change from the most ancient to the most recent. At no point in a given series can we draw a line and say: This is and that is not, a Horse—or a Camel—or a Rhinoceros. The visitor, therefore, can demonstrate for himself the evolution of the race of Horses or Camels or Rhinoceroses, within certain limits. Of the evolution of Man we have no satisfactory illustration from fossils.

It should be observed that the evolution of a race consists mainly in the adaptation of the structure of the animals to particular surroundings and habits of life. There is also a universal progress in intelligence, the more ancient animals having relatively smaller brains than their successors.

Water-color Restorations.

The water-color restorations by Charles R. Knight, done under the immediate supervision of Professor Osborn, mainly based on complete skeletons exhibited in this hall, show the *probable appearance* of the different extinct animals, according to our best judgment, as indicated by the characters of the skeleton, appearance of their nearest

surviving relatives and the habits of life for which the animals seem to have been fitted. The general proportions of the animal, the outlines and form of head and body, and, to a great extent, the expression of the features are usually accurately known from the fossil skeleton. The nature of the skin is sometimes but not often certainly known, and the coloring is always conjectural,

SCENE IN THE BAD-LANDS OF THE UINTA BASIN—TERTIARY FOSSIL FIELD OF NORTHEASTERN UTAH

the palæontologist and the artist having been guided by the coloring of living relatives and the supposed habits of the animal.

Window Transparencies.

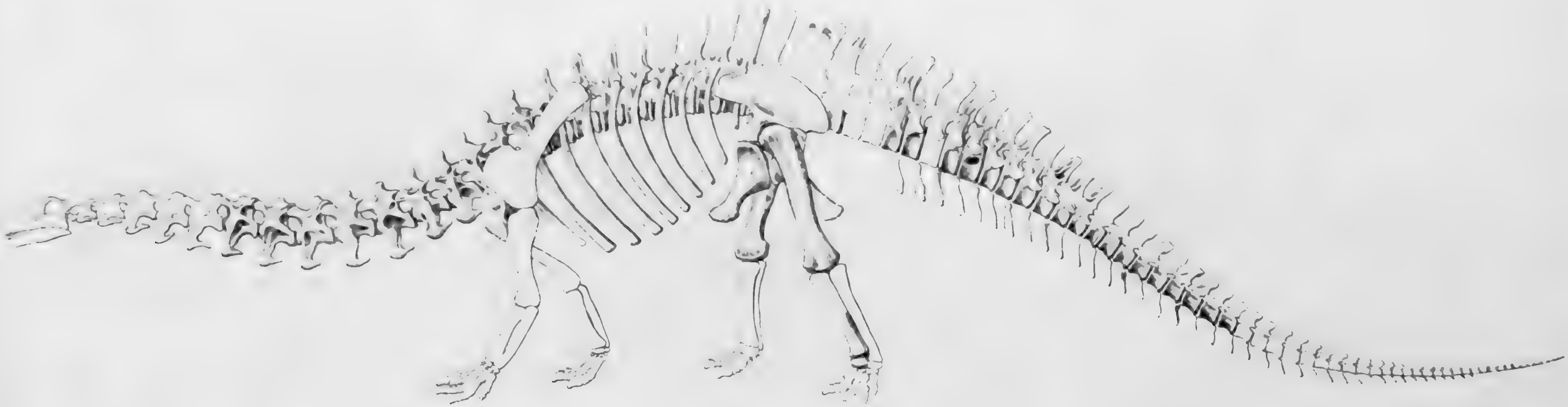
The window transparencies are enlargements from photographs of the regions where the fossils occur, and generally show the localities where unusually fine specimens in this hall were found. The expeditions sent out yearly to the fossil fields carry with them photographic outfits, and several hundred characteristic views have been taken, from

which these have been selected. The pillar cards and general labels in the cases give detailed information about each group of fossils. One of the cases in the center of the middle aisle illustrates the method by which the fossils are collected and conveyed to the Museum. The charts at each side of the entrance show the order in which the rock-strata lie, one over another, and the kinds of fossils found in each stratum.

EAST WING. HALL NO. 407. FOSSIL REPTILES, ETC.

This hall forms an introduction to an earlier world, the Age of Reptiles. These fossils are of strange and unfamiliar outlines, quite unlike ordinary quadrupeds; they represent an era, long since passed away, when reptiles were the "lords of creation." Chief among them were the Dinosaurs, great land and amphibious reptiles to which the greater part of this hall is devoted. They occupy the north, east and west sides and the center.

The Amphibious Dinosaurs, on the west and north sides and in the center of the hall, were the largest of land animals, **Amphibious Dinosaurs.** some of them sixty to seventy feet in length, and of enormous bulk. They were quadrupedal beasts, with long necks and long tails, and comparatively long and very massive limbs. The head was very small in proportion to the size of the animal, and the brain inferior to that of modern reptiles. They were cold-blooded, slow-moving, unintelligent creatures, vast storehouses of flesh which lived and grew to huge size with but little occasion for very active exertion amidst the rich vegetation of the moist and tropical climate of the reptilian era. Several incomplete skeletons of Amphibious Dinosaurs are exhibited, besides limbs and other separate parts. The Brontosaurus skeletons in Case 1 (on the right-hand or south side of the entrance) and in the center of the hall are among the largest. The thigh bone in this animal was nearly six feet long and weighs in its petrified state 500 to 600 pounds. The *Diplodocus* (Case 2 on the left-hand or north side of the entrance) was less robust but almost as long. This specimen lacks the fore part of the skeleton and most of the limbs, but the tail is very perfectly



SKELETON OF BRONTOSAURUS

RESTORATION OF THE SKELETON OF AN AMPHIBIOUS DINOSAUR OF THE AGE OF REPTILES. THE SKELETON WAS 65 FEET LONG

TAKING UP FOSSIL DINOSAUR BONES AT "BONE CABIN" QUARRY, WYOMING

Parts of several skeletons appear in the photograph

preserved. In Case 4 are limbs and other parts of several species of Amphibious Dinosaurs.

The BEAKED DINOSAURS (Predentata) northeast corner of the hall, had a horny beak or bill at the front of the jaw, and teeth at the back of it. They were most extraordinary and bizarre animals, huge in size, although not so large as the Amphibious Dinosaurs. *Stegosaurus* had a series of great bony plates projecting from the back, and stout bony spines on the tail. *Triceratops* had an enormous skull with three great horns projecting forward, and a strong bony frill projecting backward around the neck. Both these were quadrupedal animals with massive limbs and elephantine feet. *Hadrosaurus* was a bipedal dinosaur with long hind limbs and three-toed bird-like feet, but with hoofs instead of claws. Its beak was broad and flattened, as in the spoon-bill duck or Ornithorhynchus of Australia.

Beaked Dinosaurs, Stegosaurus, Triceratops and Hadrosaurus.

The CARNIVOROUS DINOSAURS are exhibited on the east side of the hall (opposite the entrance). They were bipeds with bird-like feet, sharp claws and large heads with sharp-pointed teeth. Some of these, the Megalosaurs, were of gigantic size, much larger than any modern carnivore. *Allosaurus* was as large as an elephant, while other Megalosaurs were even larger. Other Carnivorous Dinosaurs, such as *Ornitholestes*, were small and of slender proportions; these probably lived on the small animals of that period—toothed birds, pterodactyls, small reptiles of various kinds—while the large herbivorous dinosaurians were more probably the chief prey of the Megalosaur.

Carnivorous Dinosaurs.

All the Dinosaurs had become extinct by the end of the Age of Reptiles. Their place was taken by the more intelligent and adaptable mammals, the evolution of which into the different kinds of modern quadrupeds has been seen in the Hall of Fossil Mammals.

Other Reptiles—Crocodiles, Turtles, Pterodactyls etc.

On the south side of the Fossil Reptile Hall are fossil remains of four other groups of reptiles, the CROCODILES, TURTLES, LIZARDS and SNAKES, which, more fortunate than the dinosaurs, have survived to the present day, though in much diminished numbers and importance.

DIVISIONS OF THE AGE OF REPTILES
Characteristic fossil reptiles, amphibians and fishes, and the formations in which they are found

Crocodiles in their palmier days were of world-wide distribution and comprised marine as well as fresh-water types. Turtles are among the commonest of fossils in the Bad-lands and some of them of very large size. Lizards and snakes, the only common reptiles of modern times, are very rare and fragmentary as fossils, and little is known about them.

Besides these surviving groups, several extinct groups of reptiles are shown on the south side of the hall. The BELODONTS, of the dawn of the Reptilian Era, were partly intermediate between Dinosaurs and Crocodiles. The still older PELYCOSAURS were remarkable for an enormous rigid bony fin on the back; among the contemporary THERIODONTS there existed perhaps the remote ancestors of the Mammals. The PTERODACTYLS or Flying Reptiles were the most extraordinary of reptiles, tailless, with batlike wings, supported on the enormously lengthened little finger, and with a spread in the largest species of twenty feet from tip to tip. The RHYNCHOCEPHALIANS are an interesting group of very primitive reptiles, of which a single species, the Tuatara, still survives in New Zealand.

FOSSIL AMPHIBIANS.

Armored Amphibians (Stegocephalia).

The Age of Reptiles was preceded by an Age of Amphibians, when the dominant animals were allied to modern Frogs, Toads and Salamanders, but had the skulls covered by a solid bony roof and the bodies by more or less scaly armor. These Armored Amphibians have been called Stegocephalia (*στέγη, κεφαλή* = deck-head) or Labyrinthodonts (*λαβύρινθος, ὀδούς* = labyrinth-tooth, from the complicated fluting or infolding of the enamel on the teeth). Some of them, like *Eryops*, were large animals with heads eighteen inches long and a foot wide; others resembled colossal tadpoles; but the majority of them were quite small animals, either proportioned like salamanders or else long and eel-like with minute limbs or none at all.

These fossil Amphibians are the most ancient of fourfooted animals, and are not far removed from the central type from which all the higher vertebrates are believed to be descended. They are exhibited near the middle of the south side of the Hall of Fossil Reptiles.

Fossil Fishes.

Some of the finest specimens of fossil fishes in the collection are exhibited in the corridor hall. Others are placed in the southwest corner of the Fossil Reptile Hall. These range from the exceedingly ancient and archaic types, such as the huge Dinichthys of the Age of Fishes, older even than the fossil Amphibians, to more modern and familiar types such as the fossil Perch and Herring of the Green River Tertiary formation.

THE AMERICAN MUSEUM JOURNAL

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No. 2. **THE SAGINAW VALLEY COLLECTION.** By HARLAN I. SMITH, Assistant Curator of Archæology. December, 1901.

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American Museum of Natural History.

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Gives free admission to its halls on Wednesdays, Thursdays, Fridays, Saturdays and Sundays.

Provides for free illustrated lectures on Tuesdays and Saturdays.

Provides for free illustrated lectures to teachers on Saturdays.

Provides instruction to school children when accompanied by teachers.

WHAT IT IS DOING FOR ITS MEMBERS :

Gives free admission at all times.

Provides special courses of illustrated lectures.

Gives free use of Library. Issues the Journal.

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WHAT IT IS DOING FOR SCIENCE :

During the year 1902 it maintained exploring parties in various parts of the United States and in :

Siberia,	Alaska,	Central America,	Greenland,
China,	British Columbia,	Venezuela,	Baffin's Bay,
Japan,	Mexico,	Martinique,	Hudson Bay,
	The Bahamas,	St. Vincent,	Cuba.

Maintains scientific publications :

Memoirs—twenty-two have been issued.

Bulletins—sixteen volumes have been issued.

Journal—two volumes have been issued.

What the Museum Needs.

Additional members.

Increased subscriptions to defray expenses of exploring expeditions.

Funds to make additional groups similar to those in the Bird, Mammal and Ethnology Halls.

Small sums sufficient to preserve the records of the Indians of New York.

Means for collecting and preserving representative examples of animals on the verge of extinction.

Means for collecting fossils and geological specimens.

Membership Fees :

Annual Members,	$ 10.
Life Members,	100.
Fellows,	500.
Patrons,	1,000.

All money received from membership fees is used for increasing the collections.

Publications.

The publications of the Museum consist of an Annual Report, in octavo, about 80 pages ; the Bulletin, in octavo, of which one volume, consisting of about 400 pages, and about 25 plates, with numerous text figures, is published annually ; the Memoirs, in quarto, published in parts at irregular intervals; an Ethnographical Album, issued in parts, and the American Museum Journal.

The Knickerbocker Press, New York